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Commonwealth of Massachusetts

FIRE MANUAL
FOR THE
INSTRUCTION OF APPLICANTS
for
Entrance Examinations
in the
Fire Service in Cities and Towns
of the
Commonwealth of Massachusetts

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Prepared by the
MASSACHUSETTS DIVISION OF CIVIL SERVICE

The Commonwealth of Massachusetts

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FOREWORD

Fire departments are established and maintained by municipalities to provide protection to the public against injury, loss of life or property by fire, explosion or other causes. Because of the importance and the hazardous nature of this work, the fire fighter engaged in it must be physically fit and mentally alert at all times, must be intelligent, and must possess stamina and courage of the highest order. In addition, however, he must possess certain specific knowledge concerning the work if he is to perform his duties efficiently and with a minimum amount of risk to himself and to his fellow fire fighters. He should have a detailed knowledge of the dangers arising from heat, smoke, explosions, etc., caused by fire, of the hazards presented by new industries, processes and materials developed by science, of the construction of buildings and the hazards involved in the materials used or stored in them, and of the dangers inherent in the use of water at high pressures.

This manual is not a full and exhaustive treatment of the subject of fire prevention, detection, control and extinguishment. Neither is it intended to be directive in nature, nor to replace any existing publications on the subjects contained therein. It is intended to provide those who are seeking careers in the fire service with a first course in the fundamentals of the work of fire fighting, and to provide a solid foundation of study for further specialization by those seeking promotion within the fire service.

The Division of Civil Service is indebted to the National Fire Protection Association, the American Insurance Association, the International Association of Fire Chiefs and the American Red Cross for their permission to use freely, in the preparation and publishing of this manual, material from their publications.

I wish to express the thanks of the Division to the members of the committee on the revision of the manual for contributing so generously of their time and effort, to Retired Chief Clougherty of the Boston Fire Department for working so untiringly and painstakingly in revising and bringing up to date much of the material contained in the manual, to Captain Kenneth C. Arnold of the Boston Fire Department and Alfred J. Spittall of the Boston Metropolitan Chapter Red Cross for their revision of first aid, and to the staff of the Division for cooperating so willingly in all phases of the work involved in the revision.

Edward W. Powers
Director of Civil Service

PART ONE

ENTRANCE TO FIRE SERVICE

In order to become eligible for appointment, candidates for entrance to the fire service are required to pass a written examination, a physical examination, and a strength test.

The written examination for entrance to the fire service consists of questions on subjects of general information (i.e., on the spelling and meaning of words, arithmetic, geography, history, current events, etc.) and of questions based on the material set forth in Part I of this manual, with the exception of the material concerning the physical standards and the strength test requirements for fire entrance examinations. (It might be pointed out that candidates will be greatly aided in their study of those sections of Part I which concern fire apparatus and fire department equipment by actually inspecting real pieces of such apparatus and equipment. Permission to make this inspection can be readily secured at most fire stations where experienced fire fighters are usually available and willing, not only to show candidates the apparatus and equipment, but also to answer any questions which the candidates might have concerning them. The permission to candidates to inspect is, of course, subject to the condition that the inspection will not interfere with fire department routine and to the condition that apparatus and equipment shall be handled with the utmost care.)

The physical examination and the strength test are given the applicant only in the event that he passes the written examination. The present physical examination standards and the present strength test requirements are set forth at the end of Part I of this manual. Of course, if any changes are made in these in the manner authorized by law, the new standards or requirements will take precedence over the present ones.

FIRE APPARATUS

Originally, each piece of fire apparatus consisted of a vehicle and one of the following units: a pumping unit; a hose unit; a ladder unit; or a water unit. As time went on, however, the practice of placing two or more of these units on one vehicle came into existence. The resulting pieces of apparatus became known as "combinations", "triple combinations", "quadruple combinations" and "quintuple combinations", respectively. In this manual, fire apparatus will be discussed, not by considering each of these resulting pieces as a whole entity, but by considering each of the units mentioned above, of which fire apparatus is composed.

FIRE DEPARTMENT PUMPERS

The two general types of pumps used in connection with motor fire fighting apparatus are the positive-displacement and the centrifugal. The positive-displacement type includes the rotary-gear pump and the piston pump. Most new pumpers now being delivered to Fire Departments are of the centrifugal type, due to increased size of public water mains in the last decade and the resultant availability of larger volumes of water at adequate pressures through such mains. Each of these is driven by the same motor used to propel the vehicle, the pump being put into action by independent operating levers. The rotary-gear pump operates at about one-half the motor speed, the piston pump at about one-third the motor speed, and the centrifugal pump at about twice the motor speed.

Rotary and piston pumps discharge water at varying rates during the cycle of pump operation. This action tends to cause marked pulsations at the pump discharge which, if unchecked, would affect the quality of the stream, cause excessive wear on the hose, and excessive vibration in the motor. To control such pulsations, all piston pumps and most rotary-gear pumps have air domes by means of which the pulsations are reduced to a minimum and the harmful effects to the stream, hose and motor are eliminated.

The centrifugal pump delivers water by imparting to it a velocity energy which is changed to pressure energy as the water passes through the pump casing. The flow of water from the centrifugal pump is normally free from pulsation.

While most pumping is from hydrants, all pumpers should be capable of drafting water where necessary. The positive-displacement pump is very efficient in the drafting of water from a body of water (such as a pond, river, etc.) since such a pump can produce a suction sufficient to cause the water to be lifted through the suction hose into the pump. As far as the rotary-gear pump is concerned, however, if such a pump has been used for some time, the wear of its gears will render the pump incapable of drafting in a case where a very high lifting of water is involved. The suction qualities of the piston pump are not seriously affected by wear, but a stone or cinder under a valve or a faulty valve may make high lifts impossible.

In order that a centrifugal pump may draft water, it is necessary that it first be primed. This may be accomplished by means of a small auxiliary positive-displacement pump or by using the vacuum produced in the intake manifold of the propelling engine, or by an ejector on the exhaust line of the propelling engine.

It is impossible for a positive-displacement pump to create enough suction lift to raise water any appreciable height if there is an air leak, however slight, in the pump or suction hose. It is also impossible to draft water through ordinary hose because, when

the air is partially exhausted from the hose by the suction created by the action of the pump, the atmospheric pressure will collapse the hose and prevent the passage of water through it. For this reason, it is necessary to use reinforced or "hard" suction hose, a specially constructed, heavy-walled hose which is reinforced with metal rings to withstand the atmospheric pressure and prevent collapse when the air within it is partially exhausted.

All pumpers are designed to deliver water to two or more lines of hose, the use of shutoff nozzles making it possible for any or all lines to be shut off at the nozzles. The shutting off of a line of hose at the nozzle would, of course, result in an increase of pressure in the pump and, if one or more lines of hose were to be suddenly shut off, the resulting increase in pressure on the remaining line or lines in operation might endanger the fire fighters using them. To eliminate the danger to fire fighters in such a case, devices for the relieving of the excess pressure are used. On the positive-displacement pump, automatic pressure relief valves designed to operate at a definite pressure and supplemented by a hand-operated churn valve are provided so that the excess pressure may be relieved without shutting down the pump. On the centrifugal pump, a pressure regulating governor is provided to take care of the excess pressure. This regulating governor controls the speed of the motor by means of the pump pressure. The water pressure at the pump discharge operates an auxiliary throttle valve above the carburetor by means of which the motor is slowed down or speeded up, and a constant water pressure is thus maintained regardless of the opening or shutting off of nozzles.

All pumpers are provided with a shutoff gate at each outlet so that the flow of water through any or all outlets may be controlled or discontinued when necessary.

FIRE HOSE

Successful fire fighting depends upon adequate fire streams. Fire hose is the connecting link between the water supply and the fire, and of all the fire department equipment there is none more essential.

The dependability and length of life of fire hose rests upon three factors :

1. The quality and suitability of the hose purchased.
2. The care with which it is handled at fires.
3. The maintenance and care given to hose in quarters.

Kinds of Hose

Four kinds of hose used for fire fighting operations are:

- (1) Woven-jacketed, rubber-lined,
- (2) Rubber-lined with rubber cover,
- (3) Unlined,
- (4) Reinforced (hard) suction.

Woven jacketed, rubber-lined hose is the standard fire department hose used in this country. This hose consists of a single or double woven jacket, lined with rubber. It is highly efficient in carrying water, and with proper care stands hard service better than unlined linen hose.

Rubber hose is used for small lines such as booster hose. It is made to withstand rough usage and requires a minimum of maintenance in order to be kept in service.

Unlined hose is used extensively for fighting forest and brush fires because of its light weight and the ease with which it can be moved about. At some of these fires, it is necessary to stretch lines thousands of feet long in order to reach the material actually burning, and the delay which would be encountered, if the heavier woven jacketed rubber-lined hose were to be used in such cases, might permit the fire to spread beyond control. Unlined hose is also used on first-aid standpipes for the use of the occupants of a building for fire fighting purposes pending the arrival of the fire department.

Reinforced (hard) suction hose is used for supplying pumpers from a water source. This hose is reinforced with metal to prevent collapse when the pressure in the hose is reduced to less than the atmospheric pressure.

Care of Woven Jacketed, Rubber-lined Hose

Mechanical injury to hose may be caused by carelessness in handling or storing it. Hose on fire apparatus should be reloaded at least once a month—if it has not been used in that period—to change the folds and prevent kinks which may damage the hose.

Hose should be stored in a cool, dry place. Heat causes the rubber lining to harden and crack.

Failure to dry hose promptly after it has become wet may cause mildew, mold or other rotting in hose jackets. This wetting may result from use at a fire or from spray, rain, splash or other causes. Failure to dry hose properly may also cause damage to the jacket. For example, the water in one hose should never be permitted, in the drying process, to spill out on the jacket of the same or another hose because such water if it has been left in the hose, for even a short period, combines with the sulphur in the rubber lining to form sulphurous acid. This acid destroys the woven hose jacket.

Other damage to the hose jacket may be caused by its coming in contact with acids present at fire fighting operations or from chemical fire extinguishers or from batteries. Gasoline and oils are particularly ruinous to the rubber lining and the cement which holds the lining to the jacket. If the hose comes in contact with these substances, the jacket acts as a wick to absorb them and to carry them to the lining and the cement.

Since weakened hose may burst or rupture at a critical period during a fire, care should be taken to avoid any damage to hose from the above-mentioned causes.

Care in Handling Hose at Fires

The greatest wear and tear on hose comes at fires. This may be reduced to a minimum by care in handling. Lines of hose should not be dragged unnecessarily over pavements or other rough surfaces. Needless traffic should be prohibited from passing over hose, and hose should be protected against unavoidable traffic by the use of hose bridges. Hose, between the hydrant and the pumper, should be protected against chafing by using chafing blocks. Hose hoists (sometimes called hose rollers) should be used when hoisting hose to roofs and into windows. Hose wet at fires, drills or tests should be replaced with dry hose upon return to quarters.

Washing and Drying of Hose

After hose has been used, all dirt on it should be thoroughly brushed off. If the dirt cannot be removed by brushing, the hose should be washed with plain water and scrubbed. When hose has been exposed to oil, the oil may be removed by washing the hose with soap, or a mild alkali, and water and then properly rinsing the hose. The hose should then be hung up in towers, or placed on a rack or in a fire hose dryer, to dry.

Hose Couplings

Hose couplings are the metal fittings at the ends of a section of hose into which the hose is inserted and firmly attached by a brass ring which can be expanded from within to force the hose tightly against the inside of the coupling. These couplings serve to connect one section of hose with another section, and with pumpers, hydrants, apparatus and other hose equipment. One end of each section of hose is fitted with a "male coupling" which is threaded on the outer surface and the other end is fitted with a "female coupling" which is threaded on the inner surface of a swivel. Within the swivel, a rubber washer or gasket is inserted. It is important that this be in place when hose sections are being coupled. The outer surface of the male coupling and the outer surface of the swivel of the female coupling are provided with lugs. Spanner wrenches fit these lugs on the couplings which extend out half an inch from the circumference of the coupling. There are two kinds of lugs, pin lugs and rocker lugs. Pin lugs are, as the name suggests, in the shape of a cylindrical pin, which is about half an inch in diameter. Rocker lugs are about one inch long and $\frac{1}{4}$ inch wide and have a semicircular cross section, its design offering little resistance when passing over obstructions. The couplings are joined by bringing them together so that the threads engage and by turning the swivel. Applying leverage by means of spanner wrenches the couplings may be turned so tightly upon each

other that the washer or gasket between them provides a water tight and air tight seal between the hose sections.

Maintenance of Hose Couplings

Hose coupling should not be dropped or dragged as this may result in mashed threads, jammed swivels or other damage. Couplings should be kept in good order, and after hose is used the threads should be examined and any injured or defective coupling should be repaired or replaced. Each coupling should be so adjusted that it can be screwed up easily by hand. Grease or heavy oil should never be used on a coupling. If the coupling is dirty, it should be spun in a pail of soapy water.

The rubber coupling washers which are inserted in the female couplings should be renewed as needed. Care should also be taken that the rubber washers, particularly those at the nozzle, do not project into the waterway since such projection may cause a ragged fire stream.

Hose Connections

A hose connection in any of the various fittings designed to permit the making of rapid connection (other than the normal connections of hose lengths to hose lengths of the same size by means of their couplings) of hose and appliances. The names of some of the hose connections which are commonly used in fire departments and their uses are as follows:

Double Male Connection. Used to connect two female ends with identical threads.

Double Female Connection. Used to connect two male ends with identical threads.

Adapter Connection. Used to connect a male end of one thread to a female end of a different thread. Utilized under conditions of mutual aid where threads are not standard and also for connecting garden hose to booster hose.

Double Male Reducing Connection. Used to connect a female end of one thread to a female end of a smaller or different thread.

Double Female Reducing Connection. Used to connect a male end of one thread to a male end of a smaller or different thread.

Large Outlet Hydrant Suction Connection. (Commonly known as a double 4½-inch connection.) Used to connect large suction hose to 4½-inch outlet of hydrant.

Pumper Suction Connection. Used on suction inlet of pump to permit feed from two 2½-inch suction hose from hydrant, or from two 2½-inch lines of hose for relay pumping.

Small Outlet Hydrant Suction Connection. (Commonly known as a 4½ x 2½ connection.) Used to connect large suction hose to a 2½-inch outlet of hydrant.

Single Hydrant Hose Gate. (Commonly known as Morse Gate.) Provided with one male and one female end and used

on 2½-inch hydrant outlets, before hydrant is opened, to permit additional lines of hose to be connected to same, after hydrant has been opened, without necessity of shutting down hydrant. It is also used as a controlling valve for a cellar pipe, in which case it is placed between the hose couplings at a point 50 feet back from the pipe. (The reasons why it is used in this fashion are that some cellar pipes are not equipped with shutoffs and that, in the case of those which are equipped with shutoffs, such shutoffs may not be accessible if the smoke from the fire is very heavy.) It is sometimes used on the siamese connections of a water tower, monitor gun, high pressure gun or other heavy stream appliance to prevent water from flowing out of a connection at which the clapper valve is defective or leaking.

Water Thief. A fitting having one 2½-inch male and one 2½-inch female connection and two 1½-inch male gated side outlets. The use of this fitting in a 2½-inch line of hose allows the additional use of two 1½-inch lines with independent control.

Wye Connections. (Provided with one female and two or more male ends.)

Plain Wye—Used to connect two 2½-inch lines of hose from a single 2½-inch supply line. Also used on high pressure hydrants to secure the maximum of fire flow.

Gated Wye—Used for the same purposes as the plain wye connection. (The gated wye connection differs from the plain wye connection in that it has, on its branch lines, gate valves which permit each such line to be controlled independently.)

Gated Reducing Wye—Provided with gate valves and used to connect two 1½-inch lines of hose from a single 2½-inch supply line.

Two and Three Way Leader Line Wye—Used to connect two or three 1½-inch lines of hose direct from threaded tip of nozzle on end of 2½-inch hose. (This connection is provided with one female and two or three male ends.)

Siamese Connections. (Provided with one male and two or more female ends.)

Plain Siamese—Used to feed a 2½-inch line of hose from two 2½-inch supply lines.

Gated Siamese—Used for the same purpose as the plain siamese connection. (The gated siamese connection differs from the plain siamese connection in that it has, on its female ends, gate valves which permit each supply line to be controlled independently.)

Siamese with Automatic Clapper Valve—Used for the same purpose as the plain siamese connection and the gated siamese connection. (The siamese connection

with automatic clapper valve differs from the plain siamese connection and the gated siamese connection in that it has, on each of its supply lines, a clapper valve which prevents any backflow caused by excessive pressure in either supply line when the nozzle is shut down. The clapper valve will also prevent water from running out of a connection to which no hose is attached. Furthermore, in case an attached hose should suddenly burst under pressure, the clapper valve will close the opening at the point where the hose is connected to the siamese connection.)

Nozzles

A nozzle is a unit designed to fit on the outlet end of a line of hose, a heavy stream appliance, monitor guns, ladder pipes, towers, cellar pipes, etc., in order to discharge water. Water will be discharged in varying patterns and volumes depending on the type of nozzle employed.

The fundamental purpose of nozzles is to develop streams with the right pattern and sufficient projection to reach the seat of fire.

Complete Nozzle Assembly. A complete nozzle assembly consists of a play pipe, a shutoff and a nozzle tip. The play pipe is that part to which the end of the line of hose is attached. (It serves, to some extent, as a stream straightener.) The shutoff which attaches to the discharge end of the play pipe, serves to provide shutoff control for the hose stream. The nozzle tip, which attaches to the discharge end of the shutoff, serves to give the kind of hose stream desired. Interchangeable nozzle tips of various sizes are provided for the nozzle assembly so that the appropriate nozzle tip for the particular fire conditions involved may be used. Some nozzle tips are provided with male threads so that a 1½-inch leader line may be attached directly to the discharge end. When nozzle tips are provided with threads, a screw protector ring is installed to prevent damage to the threads.

Open Play or Street Pipe. An open play pipe or street pipe is a nozzle which consists of an extra long play pipe and a nozzle tip. This type of nozzle is not equipped with a shutoff. It is used mainly in cases where a stream of long duration is required on a fire which is hard to extinguish, for example, in a case where a street stream is required for a severe blaze. It is not recommended for use for inside streams. (The "open play pipe or street pipe" is not to be confused with a smaller nozzle, also called "open play pipe," which is attached to hose for the use of occupants of buildings in connection with standpipe systems.)

All-Purpose Nozzle. An all-purpose nozzle is a nozzle provided with a single valve controlled by a valve handle which may be moved to any one of three positions, the moving of the valve

handle to each position causing the nozzle either to project a solid stream through one of its outlets, or to project fog through its other outlet, or to be turned off, respectively. This nozzle is provided in different sizes: for $\frac{3}{4}$ -inch hose, 1-inch hose, $1\frac{1}{2}$ -inch hose, and $2\frac{1}{2}$ -inch hose. If a high-velocity fog is desired, the high-velocity nozzle tip is snapped into place in the fog outlet of the nozzle. If a low-velocity fog is desired, the tip is removed, and an applicator equipped with a low-velocity head is snapped into place in the fog outlet of the nozzle. A bayonet joint holds the high-velocity tip or the applicator in the nozzle.

A number of small outlets at converging angles in the head or the tip break the water into fog particles by impinging the streams from those outlets on one another. The size, design and placing of these outlets determine the velocity with which the fog particles emerge from the nozzle. Because for some fire fighting tasks a low-velocity fog is preferable while for others a high-velocity fog is preferable, this nozzle serves a most useful purpose.

For both the low-velocity head and the high-velocity tip, the water pressure is the same, since pressure is not the differentiating factor in the velocity achieved by the two. For best results with either, the water pressure at the nozzle should be maintained as close to 100 pounds per square inch as possible. They operate acceptably with a water pressure down to 40 per cent lower.

Spreader Nozzle or Lumber Pile Nozzle. Made to attach to threaded tip of regular shutoff nozzle. Provides flow of water in wide flat sheet; especially useful in lumber pile fires or in similar situations where burning material is closely spaced.

Screw Type Controlling Nozzle. Nozzle which may be adjusted to provide any size solid stream from virtual pin-point to full opening of nozzle bore, as well as complete shutoff. Provides for regulation of size of streams without interchanging of nozzle tips.

Chimney Spray Nozzle. Used to provide a spray for extinguishing fires in chimneys. A straight stream would cause a rapid contraction of flue lining and possibly result in cracks in chimney; also an excess of water would be forced into chimney by such a straight stream.

Nozzle Holder. A nozzle holder is a device designed to assist fire fighters in holding the nozzles of hand lines (particularly those in which higher pressures are used) which consists of a cradle, into which the part of the hose next to the nozzle is laid and secured in place by straps, and an adjustable leg, which is secured in place by a large thumb screw. The cradle is equipped with two hooks which can be hooked over the rungs of a ladder or attached to cornices, etc. The adjustable leg has a spike at its end so that it can be stuck in the ground or other surface to prevent back pressure from moving the nozzle holder.

Cellar Pipes

The various appliances designed to deliver water on inaccessible fires in basements, cock lofts, between decks in ships, and under wharves and like places, through holes cut in floors, roofs or decks, etc., or through cellar windows.

Distributor. (Commonly known as Bresnan Nozzle.) This nozzle is a brass globe, having nine small holes, and is revolved by water pressure. It distributes the water in all directions. A single hydrant hose gate to control it must be placed between the couplings 50 feet away.

Goose-Neck Type. Special bent pipe with either conventional or special type of spray nozzle for extinguishing cellar fires.

Fog Type. Lately adopted appliance for use on surface fires originating in basements and similar areas where access to the same cannot be readily obtained owing to the pungent gases, heat and smoke evolving from the burning materials therein. It is based upon the principle that water broken down into a fine spray will absorb a large amount of heat, clear away smoke, and absorb toxic gases (other than carbon monoxide) much more readily than the straight stream from the ordinary cellar pipe. This pipe is limited to fires on the surface of materials owing to the fact that the penetrating power of fog is negligible.

Baker. The Baker cellar pipe consists of two pipes brazed together at right angles, forming one pipe. The rod that controls the nozzle is on the outside in front of the vertical pipe. There is a long lever from rod which controls nozzle, and this enables the operator to stand back away from the hole through which the pipe is passed. A single hydrant hose gate must be placed 50 feet back from this pipe to control the water without sending back to the engine. The Baker pipe now being installed can be made to turn a complete circle and has a gate attached.

Hart. The Hart cellar pipe consists of two pipes hinged together so that they can be folded. The rod that controls the nozzle passes down inside the vertical pipe, and is carried straight up above the vertical pipe and has a short T handle. The nozzle can be made to turn a complete circle. The operator must stand directly over the hole through which this pipe is passed, but there is a spray on the vertical pipe just below the joint of the horizontal and vertical pipe, and this prevents, to some extent, the smoke from coming up through the hole.

Carey. This device is a cellar pipe constructed of wrought iron, approximately 2½ inches in diameter and 5 feet in length having a bend near the tip end, and provided with telescopic handles, making it more compact for carrying and occupying only one-half the space on apparatus that it would occupy when extended. Ordinarily it is fitted with a 1½-inch tip while the butt end is threaded to fit a 2½-inch hose coupling. This pipe is effective

for fighting fires at lower levels or through cellar windows or any place where a pipe of this design is needed. In use in basements, it permits the fire fighters to stand outside the building and well away from the wall opening, yet get a stream into a building at an effective angle.

In use, the pipe is connected to the hose, and the device extended. The pipe end is forced through a window or other opening into position, and by rolling the pipe sideways and moving up and down, quite complete coverage may be secured. This pipe is also effective for fires under wharves, docks, piers and on ships. It has an effective reaching distance consistent with the pressure at the nozzle and must be directed at the source of the fire to be effective.

Other Fire Hose Equipment

Portable Deluge Gun. A portable deluge gun is a device for discharging heavy streams of water at fires. It consists of a siamese connection with clapper valve for receiving the water from two or more lines, a short assembly pipe and a nozzle tip (usually $1\frac{1}{2}$ to 2 inches). It is equipped with an attachment by which it can either be securely braced and operated from its own special portable base or be secured to fire apparatus and operated as a deck gun. A double-swivel mechanism permits a full 360 degree horizontal, and a 180 degree vertical, swing of the nozzle.

Hose Line. A hose line is a device for securing hose to ladders or other objects to prevent the hose from being moved by sudden pressure changes and to relieve the strain on its couplings, the device consisting of a piece of one and three-fourths inch rope which is equipped with a metal ring spliced to one of its ends and a metal hook spliced to its other end.

(Note: The size "one and three-fourths inch" refers to the circumference of the rope and not to its diameter.)

When hose is to be secured to a ladder by a hose line, the hose line is passed around the hose, the hook is put through the ring and pulled until the hose line is tight and the hook is then passed around a beam of the ladder, next passed under the hose line and finally placed in position around the rope with the hook pointing up.

(Note: A "hose line" is not to be confused with a "line of hose". A "line of hose" is two or more lengths of hose coupled together so as to be long enough to reach from the source of water supply to the point where the water is to be delivered by nozzle for fire fighting operations.)

Ladder Pipe—Demountable. Since aerial ladders lend themselves well to use as water towers without detracting from their primary use, it is practical to equip them with ladder pipes. It increases the scope of a ladder company's activities, and as a potential water tower, is available on first arriving apparatus at fires. Power raising, adjustable height, revolving turntable, and

general maneuverability gives greater flexibility in use. The pipe is fitted at the inlet side with a 2½-inch female coupling and piping to swivel yoke to discharge piping which is fitted with a 2½-inch National Standard Male Thread. The swivel yoke, which permits vertical movement is controlled by an arm with a full 360 degree swing with a locking device at axis of controlling arm to lock same at approximately every 10 degrees. Horizontal swing of pipe is prevented by a spring loaded locking pin. The vertical travel of the discharge stream is accomplished or controlled by using control lines attached to the controlling arm and the ladder pipe tip. The control line is fitted with snap hooks at each end for attaching. Inlet piping is fitted with adjustable clamping device for securing to ladder and pipe is usually placed in position on the two top rungs of fly ladder. The later model ladder trucks are also provided with a permanently mounted ladder pipe connected to the top of bed ladder, thus offering ladder pipe streams from two different heights simultaneously.

Suction Strainers. Used on submerged end of suction hose to prevent passage of mud, stones and debris into pump. There are three general types: box screen, flat screen and cylinder.

Spanner Wrench. A spanner wrench is a tool which fits the lugs of hose couplings and which is used as a lever for tightening or loosening such couplings.

Hydrant Wrench. A hydrant wrench is a tool which is used to remove and put on hydrant caps, and to open and close hydrant valves.

Hose Tester. A hose tester is a device which is used for the periodic testing of hose and which consists primarily of a pump (which may be either electrically or manually operated) which is connected, on one side, with an inlet pipe equipped with a pressure gauge and which is equipped, on the other side, with a connection to which the hose which is to be tested may be attached.

(In the testing of hose with a hose tester, one end of the hose is attached to the discharge connection on the hose tester and the other end of the hose is capped with a cap equipped with a faucet or a pet cock; water is then admitted to the inlet pipe through the small valve until it fills the hose, the air being exhausted through the faucet or pet cock at the capped end of the hose; and, the pump is then operated until the desired test pressure registers on the pressure guage.)

Coupling Expander. A coupling expander is a device for inserting and securing the expansion ring which fastens a coupling to the end of a piece of hose.

Tap and Die Set. A tap and die set is a set of tools for cutting screw threads. Fire department use of these tools is usually limited to the recutting of damaged threads on couplings, hydrant nipples and all other screw-thread fire fighting equipment.

Hose Clamp. A hose clamp is a device for squeezing hose at a desired point so tightly that the flow of water through the hose will be stopped at that point. It is used in those cases where it is desired to replace defective sections of hose, or to add lengths of hose when extending a line of hose so that the latter will reach a greater distance, or to drain a line of hose so that it will not be necessary to carry a charged line of hose to upper floors, etc., without having to shut down the pump or hydrant supplying water to the hose.

Hydrant Drain Pump. A hydrant drain pump is a small portable hand pump which is designed especially for pumping water from the barrel of a hydrant which has a clogged or otherwise defective draw-off drain. The pump is equipped with a special clamp which fits the stem nut of the hydrant to secure it in place while it is being operated.

Basement Ejector Siphon. A basement ejector siphon is a portable, metal device designed to remove water from flooded basements, etc., without the necessity of using the pumper. It has a small intake opening on its side, a large outlet connection at its top and a base with small holes in its side for admitting and for screening from it any debris in the water to be removed. A water stream under pressure enters the device through the small intake opening and creates a siphon effect, lifting the water which has entered through the small holes. The water which is desired to be removed, as well as the water which enters under pressure, is discharged at a low pressure through the large outlet.

Hose Bridge. A hose bridge is a device for permitting fire department apparatus and other vehicles to pass over an operating line of hose without injury to the hose. One common kind of hose bridge consists of two wedge-shaped blocks of wood or metal, each block being placed with its high end against one side of the hose opposite a block similarly placed against the other side of the hose. Bridges are placed in pairs so as to form a bridge over the hose for the wheels on both sides of the vehicles.

(The blocks of a hose bridge may also be used as ramps, to enable fire apparatus to be drawn over curbs, railroad tracks or similar obstructions.)

Burst Hose Jacket. A burst hose jacket is a hinged, two-part, rubber-lined, metal jacket which, when clamped shut over the burst part of a hose being operated at a fire, forms a seal to prevent the loss of water and pressure.

By the use of a burst hose jacket, unless the opening is so large as to preclude its use, the necessity for shutting off lines of hose or for replacing defective sections of hose is eliminated. The burst hose jacket may also be applied over couplings in a case where it is desired to connect two sections of hose which cannot be connected in the regular way owing to defective or non-standard threads.

Hose Hanger. A hose hanger is a device for holding hose suspended in a tower to dry. It consists of an attachment for gripping the hose by its coupling and a hook for hanging it on the bar from which the hose is suspended.

Rope Hose Tool. A rope hose tool is a belt which is made of rope and equipped with a hook by which it may be fastened to things and which is used for many purposes, such as, those of carrying hose, of securing lines to ladders and other objects, of securing ladders in place, of rescue operations, etc.

Hose Drying Rack. A hose drying rack in a fire station is a permanent rack (constructed with one end higher than the other to allow the hose to drain) upon which hose is laid to dry. It is built in tiers arranged so that water dripping from the couplings of hose on the upper tiers will not drop on hose sections on the tiers below. (The water dripping from hose linings has a sulphurous acid content which is harmful to hose.)

Hose Storage Rack. A hose storage rack is a framework which is made of wood or metal and on which rolled sections of dry hose are stacked upright and kept pending their use.

Fire Hose Dryer. A fire hose dryer is a device which serves the purpose of drying hose by means of artificial heat and which consists of a heavy gauge steel cabinet containing shelves (on each of which a rolled section of hose is laid flat) and electric heaters. The fire hose dryer can accommodate 500 feet of hose at one time. The dryer operates on the principle of circulation of prewarmed air. Air is taken into the cabinet through a vertical duct at the rear of the dryer where it is warmed slightly by passing over shielded electric heaters. It is then drawn to the bottom of the unit and enters the cabinet proper through a perforated baffle. An exhaust fan at the top of the cabinet pulls the preheated air up through the coiled hose, and after removing the moisture from the cotton hose jackets the air is expelled through an opening in the top dome. The unit will usually dry 500 feet of hose in six or seven hours, depending on the age of the hose, the amount of water it has absorbed and the relative humidity of the room in which the unit is located. The maximum temperature of the preheated air in circulation in the dryer does not exceed 100 degrees, Fahrenheit.

Hose Pole. A hose pole is a device which serves to facilitate the passing of hose from one man to another when such hose is being passed from a fire escape balcony or from a window to an upper floor or to a roof. It consists of a long pole which has a pike and hook at one end and a hose chain at the other end, the hose chain being used to hold the hose by being looped around it and the hook being used to suspend the hose pole and the attached hose from railing, cornices and similar objects.

Hose Loader. A hose loader is a device which serves to facilitate the loading of rolled hose into a folded position on the bed of

fire apparatus. It consists of a horizontal rotating table or wheel placed on a vertical axle which is set upright in a heavy base. The rolled hose is laid on top of the table or wheel which revolves when the hose is reeled off.

(The use of the hose loader eliminates kinking of the hose and also minimizes the possibility that the hose will be dragged through water which might be on the floor of the fire station.)

Hose Carrying Harness. A hose carrying harness is a device, made of leather straps or rope, for the carrying of a rolled length of hose on the back of a person in knapsack fashion.

Hose Hoist. A hose hoist is a special roller device which serves to facilitate the hoisting of hose, ladders and other heavy objects to the upper floors, or to the roof, of a building, and to eliminate the chafing of ropes on the rough edges of roof cornices or window sills. It consists of a metal framework which has two parallel side-pieces, shaped to permit the framework to be hooked over the edge of a window sill or the edge of a roof when it is laid flat across the window sill or the parapet of the roof. It has, among its several crosspieces, two rollers which, when the device is properly placed, will be in such a position that the objects to be hoisted may be hauled easily up over them.

When the hose hoist is being used, it should be placed so that the hooks are outside the building and facing down. The curved parts of the sidepieces will then be at the edge of the sill or roof and the straight parts of the sidepieces will be resting on the sill or parapet of the roof.

When a hose hoist is to be used to haul anything to the upper part of a building, a rope should be attached to the hose hoist and the latter should then be made fast. This should be done, if possible, by passing one end of the rope several times around a chimney or other substantial projection and then securely tying it. Sometimes, a dog chain is used to make the hose hoist secure.

Use of Fire Hose Equipment

Definition of Life Line. A life line is a heavy, strong, manila rope, usually 3 inches in circumference and 100 to 150 feet in length, used for rescue work and as a precautionary measure as well as in hoisting or lowering operations.

To Use a Life Line. When it is being employed in rescue work, the life line is used to lower persons from a roof or window of a building or to hoist from the hold of a ship, manholes or well holes. A flexible stretcher or hauling harness is generally used with the life line when it is necessary to hoist or lower persons who have been injured, burned, or overcome. When it is being employed as a precautionary measure, the life line is attached to fire fighters who undertake tasks involving more than ordinary risks. It is manned by a fellow fire fighter who stands by ready to come to the fire fighters aid or to haul away on receipt of any prearranged

departmental signal or when he believes his charge is in trouble. When it is being employed in hoisting or lowering operations, the life line is made fast to tools, appliances, hose, etc., which are then hoisted or lowered to the desired location.

When a life line is being used to hoist or lower heavy objects from a height, a hose hoist should be fastened over the edge of the sill or roof and the life line led over the rollers to prevent friction from damaging the line. To tie a life line to a line of hose which is to be hoisted or lowered by a life line:—if the hose is empty, with a clove hitch make the life line fast to the hose about 4 feet from the end of the play pipe; if the hose is full of water, with a clove hitch make the life line fast to the hose about 4 feet from the end of the play pipe, and take a half hitch over the play pipe.

To Take Hose over Ladders. The nozzleman picks up the play pipe end of the hose, places it over his right shoulder and passes it down along his back until the tip is just below his belt. Then, with the attached hose passing down in front of him and between his feet, he climbs the ladder until he reaches the level desired. Other men take positions about twenty feet apart, pick up the hose and move forward until they are ten feet apart. This movement causes a loop of hose to exist between each man and the man in front of him. By moving at the same speed as the nozzleman, the men can maintain the loops and, by carrying them, greatly assist him in bearing the weight of the hose. When the desired level on the ladder has been reached, each man on the ladder gets a leg hold on it by putting his left leg between its rungs, and locking his in-step under the next lower rung.

If the hose is to be taken through a window or onto a roof, the nozzleman takes the pipe from his right shoulder, and passes it and some of the attached hose through the window or onto the roof. Then he releases his leg lock and climbs through the window or onto the roof. Sufficient hose must be taken into the window or onto the roof so that every portion of the floor or roof where there is a fire, or to which fire may extend, can be covered by an effective stream. The other men lift the hose up the ladder, as far as required. Each man on the ladder then secures the hose to the ladder with a hose line, releases his leg lock, and moves up and into the building or onto the roof where the line of hose is to be operated.

If the hose is to be played from the ladder, the nozzleman, when he reaches the desired level on the ladder, after locking himself in on ladder, takes the play pipe from his right shoulder, passes it over the desired rung, and secures the hose to the ladder at a point about one foot back of the play pipe with a hose line. Each man on the ladder after locking himself in then lowers the extra hose down in front of him and secures the hose to the ladder with a hose line.

(NOTE: Some fire departments require the use of two hose

lines to secure the hose to the ladder, each hose line being passed around a different beam of the ladder in such a case, and some departments require that a rope hose tool be used instead of the leg lock to secure the man to the rung of the ladder.)

FORCIBLE ENTRY EQUIPMENT

In connection with the work of the fire department, "forcible entry equipment" means the instruments and tools designed for the emergency opening of locked doors and windows, and of roofs, floors, skylights, partitions and walls. Much of this equipment is peculiar to the fire service and is the result of improvements based on actual fire fighting experience.

A large variety of forcible entry tools, all similar in general purpose, are used in different fire departments. Those widespread in use are discussed here.

In using forcible entry equipment, care should be exercised to keep damage at a minimum consistent with the conditions met at the scene of the fire. A large measure of responsibility for the careful use of forcible entry equipment falls on the individual fire fighter.

Pick Head Axe (commonly called a Pean Axe). A pick head axe is an axe consisting of an edged head, attached or fixed to a handle, which has a cutting blade at one end of its head and a short, pointed pick at the other end of its head. (The pick head axe is the axe which is most commonly used in fire departments. The pick end of its head is used for prying up flooring and for breaking through brick, mortar, plaster, etc. The blade end is used for cutting operations. The weight of the standard pick head axe is 6 pounds. There are, however, heavier pick head axes for rough and heavy cutting work.)

Pry-Axe. A strong, multi-purpose forcible entry tool, only 18 inches long, weighing under seven pounds. By pressing a release button, one man can release the claw and use it as two separate tools. Use the head as a ram, to supply driving power to the claw, or extend the length of the tool for added leverage.

Flat Head Axe. A flat head axe is an axe consisting of an edged head, attached or fixed to a long handle, which has a cutting blade at one end of its head and a blunt and flat surface at the other end of its head.

(The flat head axe is usually employed for cutting operations. It may, however, be used as an aid in the opening of locked doors. In this latter case, its blade is driven between the door and the jamb by striking its flat head with a sledge. The flat head axe may be used as a sledge in emergencies.)

Hand Hatchet. A hand hatchet is a small, light axe consisting of an edged head, attached or fixed to a short handle, which is de-

signed to be used with one hand and which has a cutting blade at one end of its head and a flat or other surface at the other end of its head.

(The hand hatchet is useful for light cutting work or for removing laths and plaster from such places as narrow shafts, closets, the confined spaces back of radiators and pipes, and other places where there is not enough room to swing a regular axe.)

Hammer Head Pick. A hammer head pick is a pick consisting of a pointed head, attached to a handle, which has a long, slender, sharp point at one end of its head and a heavy flat striking part at the other end of its head.

(The hammer head pick is commonly known as "the brick wall pick." It is suitable for use under any conditions calling for the use of a pick. Besides, the pick end of the hammer head pick can be driven into hard materials by striking its flat head with a sledge.)

Claw Tool. A claw tool is a tool which is designed for prying, forcing and other entry work. It consists of a bar terminating at one end in a forked wedge for prying and at the other end in a hook for pulling hasps and breaking locks. A raised spur on the bar, at the back of the hook at the point where the hook begins, provides for greater leverage when that is needed.

Halligan Tool. The Halligan Tool is a multiple-purpose tool, approximately 32 inches in length and 8½ pounds in weight, consisting of a bar which terminates at one end in a fork and at the other end in a head which has an adz and a hook at right angles to each other. (It is suitable for use under conditions calling for the use of a fork which can be driven in to penetrate heavy materials, under conditions calling for the use of an adz to open doors or remove light trim, baseboards, roofing, etc., and under conditions calling for the use of a hook to remove locks, hasps, staples, etc., or to lift manhole covers.)

Buster Bar. A buster bar is a light, door-opening and prying tool consisting of a steel bar, approximately eighteen inches in length, which terminates at one end in a handle and at the other end in a slightly-curving, wedged-shaped chisel. A self-adjusting fulcrum is attached to the bar at the back of the curve at the point where the curve begins.

(The buster bar is widely used for forcing doors and windows and for prying where heavy construction is not encountered.)

Callahan Jimmy. A Callahan jimmy is a door-opening tool consisting of a steel crowbar with a weighted handle which slides up and down the bar and by which the curving wedge-shaped end of the bar may be driven between the door and the doorframe.

Battering Ram. A battering ram is a tool for forcing solid doors and breaching brick walls. It consists of a heavy steel bar terminating at one end in a ball-shaped head for battering and at

the other end in a wedge-shaped claw for removing bricks. It is designed to be operated by being swung by four men, one man for each of the four handles with which the tool is provided.

Window Breaker. A window breaker is a device for breaking windows which cannot be reached by other means. It consists of a heavy metal ball to which a long chain is attached. In using it, a man on a roof or an upper floor holds the window breaker by the chain with the ball part suspended so that the ball is right in front of the window desired to be broken and then swings the ball away from him so that the latter will swing back against the window and break it. When a fire fighter is operating from the roof of a building to perform this function he should lie in a prone position in order that momentum which may occur on swinging breaker will not carry him off the roof.

Sledge (or Maul). A sledge is a large, heavy hammer designed to be wielded with both hands and to be used for breaking concrete, bricks, window bars, rivets, etc.

Engineer's Hammer. An engineer's hammer is a one-hand sledge hammer which is designed for lighter work than the ordinary sledge.

Pike Pole. A pike pole is a tool which is used for the removal of tin and plaster ceilings and plaster partitions and for other prying operations calling for the use of a long-handled tool. It consists of a pole which has, at one end, a metal point for piercing purposes and a short hook for prying and pulling purposes.

(Pike poles vary in length according to the conditions under which they are to be used.)

Plaster Hook (commonly called a Rake). A plaster hook is a tool which is used for the removal of plaster ceilings and partitions and for other cutting operations calling for the use of a long-handled tool. It consists of a pole which has, at one of its ends, a long hook having a tempered cutting blade.

Roof Cutter. A roof cutter is a device used for cutting and removing metal sheeting on roofs and other similar surfaces and consisting of a wooden handle which has a horizontal hand grip (like that which is found on the handles of some shovels) at one end and, at its other end, a cutting head shaped like that of the old-fashioned can opener. The device is operated just as such a can opener is operated, in that its point is first dug through the metal and then the cutter is worked in can opener fashion away from the operator.

Pull Down Hook. A pull down hook is a device which is used for pulling down damaged walls and cornices and other damaged structures. It consists of a heavy, forged hook with a shank to which a long chain is welded and on which is a socket into which the top of a long pole may be inserted. The device is operated by catching the hook over the top of the damaged structure and pull-

ing down. A rope is usually attached to the chain so that the men pulling may take positions far enough away so as not to be hit by falling material.

Wire Cutter. A wire cutter is a device which is used for cutting fallen wires, or wires that interfere with operations at a fire, so that they may be removed. It consists of two long insulated handles (which look somewhat like those of a long-handled pair of pliers), a cutting blade mechanism and a wire-holding hook into which the cutting blade moves. The squeezing together of the handles causes the operation of the mechanism which forces the cutting blade through the wire which is held in the hook.

(A wire cutter should not be used on live wires except by a qualified operator.)

Fire Fighter's Saw. A fire fighter's saw is a specially designed convex saw for cutting timbers, boards, planking, etc. Its nearly semi-circular shape makes it possible to start a cutting operation on a flat surface. The teeth are coarse for quick cutting and are hardened so that contact with metal will not render the saw unusable.

Emergency Kit. An emergency kit (which is sometimes called an "elevator kit") is a set of tools and appliances for use in case of elevator accidents and other exigencies and which includes the following:

Cutting Pliers	Hacksaw
Gas Pliers	Hot Chisel
Bolt Cutter	Punches
Pipe Cutter	Cold Chisel
Tinners' Shears	Hammers
Keyhole Saw	Pipe Wrench
Hand Brace	Shallow Jacks
Bit Stock Twist Drill	Wooden Wedges

Oxygen-Acetylene Torch. An oxyacetylene torch is a device for welding and cutting metals by the heat of oxyacetylene flames. It consist of a cylinder of oxygen, a cylinder of acetylene, two regulators, two lengths of hose and a welding blow pipe supplemented either by a cutting attachment or by a separate cutting blowpipe.

Heavy metal bars and plates, which could be cut with such tools as chisels or saws, etc., only with the greatest of difficulty, are cut with ease by the oxyacetylene torch. The blowpipe is really a miniature furnace with which metals may be heated to such a temperature that they readily melt. When the cutting is in progress, the velocity of the gases from the nozzle of the blowpipe forces the melted metal free from the cut and leaves the cut clear.

Electric Saw Gun. An electric saw gun is a specially designed appliance which can be attached to a portable electric drill for the purpose of converting the drill into a power hacksaw. It may

be used to cut iron gratings, steel bars, padlocks and door bolts and to open spaces in partitions, floors, and ceilings to expedite fire fighting operations.

Hydraulic Tools

Rescue Kits. Hand operated hydraulic pumps are used to power the tools and attachments contained in these kits which are used for freeing victims trapped in vehicles, buildings, machinery, plane crashes, etc.

Hydraulic Jacks. Lifting jacks of large capacity, 5 to 50 tons, are used in heavy rescue operations.

Hydraulic Hose Clamps. A hose clamp which uses the power of a hydraulic cylinder to clamp the hose and shut off the water flow.

LADDER TRUCKS

A ladder truck is a piece of mobile fire apparatus carrying ladders, forcible entry tools and appliances, and some rescue equipment.

In communities where building heights are not excessive, a small aerial ladder truck sometimes termed "junior aerial" is used. These trucks carry a 65-foot automatic aerial ladder. Such machines are rear-wheel drive and are readily handled from the driver's seat like a pumper or hose truck. The aerial ladder can be raised and extended by one man in a few seconds.

In cities and towns having buildings of considerable height, the need for longer ladders is met by the standard aerial ladder truck. This truck is usually on a semi-trailer chassis drawn by a four-wheel tractor. The semi-trailer wheels usually have a separate steering apparatus. Modern aerial ladders are made in three or four sections extending up to 100 feet in length. Special alloy metals are rapidly taking the place of wood for the ladder. The raising mechanism of these new metal or part-metal ladders may be either coil springs or a piston in which oil under pressure is used. Pressure is obtained by compressed air or by a pump operated from the automobile motor. The extensions, called fly ladders, are raised by means of cables with manual power or power supplied by the motor.

An aerial ladder may be operated as a water tower for playing streams on a fire from a high elevation. Such use permits streams to be played into upper stories at a lesser angle than from the ground, thus giving better penetration. The number and length of ladders carried on the standard aerial ladder truck vary with the make of the truck and the individual requirements of the city. A total of 208 feet, exclusive of the aerial ladder, has been found desirable. A 50-foot extension ladder and an assortment of shorter extension ladders, straight wall ladders and roof ladders with folding hooks are usually carried, as well as tools for forcible entry. A life net is also provided as standard equipment. Water tanks with

booster pumps are sometimes provided, thus making such trucks available for primary extinguishing operations on small to moderate fires. By virtue of their greater length, quickness and ease of operation and placement, aerial ladders are frequently of great value in rescue operations.

LADDERS

General Types of Ladders

Fire department ladders are constructed of wood, metal or a combination of wood and metal. They are of six general types, as follows:

1. Straight Wall Ladder
2. Extension Ladder
3. Roof Ladder
4. Folding Ladder
5. Pompier Ladder
6. Aerial Ladder

Straight Wall Ladders and Extension Ladders. These ladders are known as ground ladders, as they are usually raised with butts resting on the ground. All ground ladders are provided on butt ends, and sometimes on both ends, with a metal spur or shoe to provide firm footing for ladder when raised. Ground ladders are of two general types of construction, as follows: Solid beam types are constructed with rungs inserted between two solid longitudinal beams. Trussed beam ladders have two longitudinal beams, each consisting of two separate members held together by spacer blocks at given intervals, thus resembling a conventional truss, both in appearance and action. Trussed beam ladders are again of two general types. One type has both beam members of equal size, with spacers at intervals equivalent to the rung spacing; rungs are inserted in the rung block or spacers. The second type has one of the beam members of greater cross-section than the other, both members being held together by spacers at intervals greater than the rung spacing; rungs are inserted in the larger beam member, known as the main or rung beam in this case; the other beam member is known as the truss beam; in the longer ladders of this type it is sometimes necessary to introduce diagonal cross braces at intervals between the two beam members.

Ground ladders may be of wood, aluminum alloy or a combination of wood and aluminum alloy. All-steel construction is unsatisfactory because of its weight.

Straight wall ladders are generally available in lengths of from 10 to 35 feet.

Extension ladders are generally available in lengths of from 16 to 65 feet, and may be of double or triple section type. The triple section type has double fly sections to permit greater extended length within practical collapse length or safety limits.

Short Extension Ladder. Similar to ordinary extension ladder, but of special short length for carrying and raising by one man. Provided with halyard for extending fly. Ladders of this type are available in 16 to 24-foot lengths.

Baby Extension Ladder. Similar to short extension ladder, but without halyard for raising fly ladder. Fly must be raised by hand and is held in position by engaging pawls at butt or fly over upper rungs of main ladder.

Roof Ladder. Similar to straight wall ladder, but provided in shorter lengths and lighter construction. Roof ladders range from 10 to 20 feet in length. They have steel hooks at the upper end and are used for various purposes, but chiefly to lay on slanting roofs, or to go from one balcony fire escape to another.

On some roof ladders the hooks are held by springs, and when not in use are turned in out of the way.

Folding Ladder (commonly called a Pencil Ladder). Popular type of ladder for gaining access to attics through trap doors located in closets, and for similar work where space is limited. Rungs of ladder are pivoted between two parallel beams, which may be folded together when not in use, in the form of a single beam, making a convenient pole for carrying. Ladder may be locked in open position for safety. On some types, special shoes with swivels are provided to prevent slipping on smooth surfaces.

Pompier Ladder. A ladder for scaling walls by engaging hook portion over window sills and like protrusions. Consists of a single wooden beam 16 feet long banded with metal and having a 2-foot 6-inch steel gooseneck hook, with teeth to prevent slipping, at the top. The rungs are wooden crossbars, 12 inches long, set through the beam. Two curved metal plates on the hook side, one at the top and one at the bottom, keep the ladder two inches from the wall to allow the hand to grasp the beam. When using this ladder, the beam should always be grasped, and not the rungs. When using the pompier ladder, the life belt is worn. Pompier ladders are used primarily in Fire Department Drill Schools to give the recruits confidence and to overcome fear of height.

Aerial Ladder. The fixed ladder described under the heading "Ladder Trucks."

Ladder Parts and Equipment

Ladder Parts. The two long sidepieces of a ladder are called beams. The crosspieces inserted at intervals into the beams and supported by them are called rungs or rounds. The top of a ladder is called the tip, and the bottom called the butt, foot, heel or base. If a ladder consists of but one section it is called a straight wall ladder. If it consists of more than one section it is called an extension ladder. The lower section of an extension ladder is called the main or bed ladder. The upper section is called the fly ladder or fly. On both upper and lower sections are fixed metal guides

designed to permit the sections to glide upon each other yet to remain sufficiently rigidly attached to each other to bear the weight of persons on the fly when the ladder is extended to its full length.

Fly Rope or Halyard. A rope used on extension ladders to raise or lower the fly. It is fastened to the lowest rung of the fly ladder and run through a pulley attached to the rung at the tip of the bed ladder. Pulling on the halyard raises the fly ladder and releasing the rope lowers it.

Ladder Lock or Pawl. A device installed on each beam of a fly ladder which permits it to be extended without interference, but which prevents the fly from being lowered without first releasing the hook of the pawl.

Crotch or Tormentor Poles. Hand push poles attached to sides of long ladders to facilitate raising or anchoring and to prevent the ladder from sagging when an exceptionally heavy weight is placed on the ladder. Poles may be permanently attached to ladder beams or may be removable. The removable type have a pike point at one end, and a universal joint and toggle at the other. When raising the ladder the toggles are fitted into holes bored through the beams, and held in place by spring catches on the inside of the beam.

Dog Chain. A piece of chain about 2 feet long, having at one end a spike bent at right angles and at the other end a ring (snap hooks are sometimes attached to fasten "dog" chain to fire escape, etc.). This device is used principally for securing the upper part of a ladder where it rests against a window sill, roof, fire escape, or any other part of a building. To "dog" a ladder, place chain around beam of ladder, under a rung, and below roof or sill, bring spike end of chain back inside beam and pass spike through ring; draw loop in chain tight around beam and carry spike end of chain across and away from ladder and drive securely into some firm place. If in a window, the ladder is pushed to the left, and the "dog" chain put around right beam of ladder, and the spike is driven to the left side, the ladder is drawn securely against the left side of the window. If on a roof, a "dog" chain is used on each beam of the ladder and the chains are crossed to opposite sides to prevent the ladder from slipping sideways. When it is impossible to drive the spike into a window sill because of masonry construction, a plaster hook is placed across the opening on the inside near the sill and the dog chain is secured to the plaster hook. When it is impossible to drive the spike into a roof because of metal or masonry construction, the top of the ladder is secured by a life or hauling line to some substantial projection on the roof.

Care and Use of Ladders

Distance of Base of Ladder from Building Walls. The distance to set the base of a solid beam ladder from a building is cal-

culated on the basis of allowing the base of the ladder to stand one foot from building for every eight feet in length of ladder. The distance to set the base of a trussed ladder from the building is to allow one foot for every five feet in length of ladder and add 2. In many instances, various manufacturers give other figures to arrive at the proper distance, and when these are given they should be followed, but for the solid beam and trussed ladders in use in this State the above figures are safe. If there is a cornice on the building, allowance should be made for its width by adding the width of the cornice to the base line required for that ladder.

Vertical Height of Ladder. When a ladder is properly placed against a building, the vertical height to which it will reach will range from a few inches (for short ladders) to 2 or 3 feet (for long ladders) less than the given length of the ladder.

Inspection of Ladders. Inspect ladders for cracked or splintered beams and rungs, worn or frayed halyards and other like defects at frequent intervals.

Varnishing Ladders. (Ladders should never be painted because paint may conceal the defects which exist in them.) Use two coats of clear varnish, removing old varnish before applying, and allow time for first coat to dry completely and be rubbed before applying second coat. Before ladders are revarnished, they should be sand papered and planed, if necessary, to remove slivers and splinters.

*Rules for Maximum Number of Men Working on Ladders
That Have Been Raised and Readied for Use.*

Folding Ladders—designed for one-man use.

Small Inside Extension Ladders—designed for one-man use.

Pompier Ladders—designed for two-man use.

Roof Ladders—when resting on roof, these ladders are satisfactory with a man on every other rung.

Straight Wall Ladders

- a. For solid beam type up to 20 foot length not over two men on ladder.
- b. For solid beam type over 20 feet, not over three men on ladder.
- c. For trussed type up to 20 feet, not over 3 men on ladder.
- d. For trussed type over 20 feet, not over 4 men on ladder.

Extension Ladders

- a. For solid beam extension ladders from 16 to 26 feet, not over two men on ladder.
- b. For solid beam extension ladders over 26 feet, not over three men on ladder.
- c. For trussed extension ladders not over 26 feet, not over 3 men on ladder.

- d. For trussed extension ladders 26 to 35 feet, not over 4 men on ladder.
- e. For trussed extension ladders 36 to 45 feet, not over 5 men on ladder.
- f. For trussed extension ladders over 45 feet, not over 6 men on ladder.

Ladder Practices

Ladders are emergency equipment for firemen. They are usually in use at those times in the fire fighting process when every second counts.

Fire fighters should know just how to carry, raise and climb ladders most efficiently, and should practice the carrying, raising, and climbing of them until these operations become as nearly automatic as it is humanly possible to make them. Even men who have had years of experience in this work find that by such practice they can discover quicker and more efficient ways of performing these operations.

Raising 30-foot Straight Wall Ladder. Three men are required to raise this ladder. (If more than that number attempt to raise the ladder, they are in each other's way, confusion and lost motion result and the ever present danger of accidents is increased.) Take ladder from truck. Lift the ladder shoulder high and place arm through, one man near center and one at either end so that ladder balances properly. Carry the ladder, grasping either the rung or beam with the hand that is through the ladder, leaving the other hand free. Lay ladder on ground and if possible in line with front of building, bottom of butt immediately beneath the point to be reached. See that there are no obstructions overhead to interfere with the raising of the ladder.

One man takes his position at the butt with both feet on bottom rung, stooping down and grasping the third rung with both hands. (A shorter man may find the second rung more practicable.) As the ladder is raised, this man keeps bearing backwards until the ladder reaches the vertical. The other two men take their positions about 10 feet or $\frac{1}{3}$ the distance from the top of the ladder, one on each side of the beams facing each other.

At the command "Down," both men grasp a rung with the hand nearest the butt end.

At the command "Up," both men lift the ladder off the ground, at the same time getting their free hands on the underside of the beams. When the ladder is high enough so that they can get under the beams, they raise the ladder to a vertical position, pushing steadily upward, hand over hand, on the beams, and walking toward the butt of the ladder. When the ladder is vertical, the "butt" man grasps both beams, one with each hand, arms straight forward in front of the body. This position is maintained by him until evolution is completed. The men who were on the beams step

around to the side of beam, grasping beams with one hand extended and grasping second rung with other hand. The ladder is then turned toward building, the man on the beam nearest building simply pivoting, and the other man lifting the ladder slightly and making a quarter turn of the ladder. The two men on the beam then put their foot on bottom rung of ladder (the foot nearest to the other man), and with one hand on rung and one on beam (with arms straight forward), ease the ladder into the building.

NOTE: When raising, lowering, or moving any ladder, keep your eyes on the tip. The butt will take care of itself.

Raising 35-foot Extension Ladder. This ladder is raised in the same manner as the 30-foot straight wall ladder, except that in addition the fly ladder is raised, when the ladder is at the vertical and turned to the building, by the "butt" man hauling on the rope, hand over hand.

Raising Longer Extension Ladders. The 45-foot extension ladder requires five men to raise it. Take ladder from truck and carry it on shoulders. Lay it on ground and if possible in line with front of building, bottom of butt immediately beneath the point to be reached, tip or fly underneath. Crotch poles should be placed on top with pikes of pole at tip end. See that there are no obstructions overhead to interfere with the raising of the ladder.

At the command "On the Poles," four men take the poles, one at each end of each pole. The poles are taken towards the tip end as quickly as possible until the toggle irons can be pushed into their proper places. The toggles should be drawn back hard to make sure that the springs are caught.

The "butt" man, stepping on the bottom rung of ladder, heels up tight against the rung and side of feet up close to beams, stoops down and grasps the third rung with both hands. (A shorter man may find the second rung more practicable.)

At the command "Up," the men who are at the toggle end of the poles grasp the beam nearest them with both hands and lift the ladder and as the tip end starts to rise move rapidly down toward the butt end pushing up as they come with eyes raised, watching the tip. When the tip end is 8 or 10 feet from the ground, the other men on the poles (standing outside the poles and watching the tip end of ladder) push steadily upward on the poles, at the same time moving rapidly toward the butt of ladder, keeping the poles directly under the beams. If the poles are not kept directly under the beams, the top of the ladder will have a tendency to tip to the side and fall to the ground.

When the ladder has been raised to the vertical and turned toward building, the tip is raised by two men hauling on the rope, hand over hand. When the ladder is high enough the tip is let down a few inches until the pawls catch. The men on the poles then ease the ladder in until it rests against the building. The

poles are then carried around and the ends set close to building to brace the ladder. **THE FIRST MAN TO GO OVER ANY EXTENSION LADDER WHICH HAS BEEN EXTENDED MUST MAKE SURE THAT THE PAWLS ARE CAUGHT BEFORE HE STEPS UPON THE FLY LADDER.**

The 50 and 55-foot extension ladders are raised in like manner except that owing to the additional weight of these ladders four men instead of two are placed on the beams at the toggle end of the poles to assist in raising the ladder and two "butt" men are used, if possible, thus requiring a total of eight men to perform the operation.

FIRE EXTINGUISHERS

General Information

In the fire service, the term "fire extinguisher" means a portable first-aid appliance designed to provide a small quantity of water or other extinguishing agents to cope with fires in their incipency.

The action of all extinguishing agents is that of cooling the burning substance to a point below its ignition temperature or of excluding the air supply, or a combination of the two. In some types, there is also a chemical action, not fully explained, tending to inhibit oxidation. To be effective when used on fires in their incipient stage, fire extinguishers must be applied before the fire has spread to such an extent as to involve a large amount of combustible material.

It is a standard practice of fire departments to purchase only extinguishers bearing the label of the Underwriters' Laboratories, Inc. Extinguishers bearing the UL label have been tested to determine if they conform to certain standards which assure the reliability and suitability of the extinguishers for the purposes for which they were designed. When most extinguishers are put into operation, an internal pressure is developed and unless the component parts of the extinguishers are strong enough to withstand the tensile strain put on them, they are apt to rupture and injure the operator. Extinguishers which have been damaged in any way should be returned to the manufacturer for repairs.

For centuries, water has played the principal part in the extinguishment of fire. Because of its universal abundance, its low cost, its flexibility, its ease of application and handling, the ease with which it is conveyed over great distances, and the fact that its pressure can be increased by pumps, it has been, and probably will continue to be, the most widely used extinguishing agent for fire fighting operations.

However, modern science has produced certain chemical substitutes for water which are equal to, and in most instances superior, to water in the extinguishment of fires in certain materials and substances. Until the present time, the use of these

chemical substitutes has been limited to the extinguishment of fires in their incipency, and for that reason, their use, for the most part, has been confined to portable extinguishers. It is doubtful whether the supply and use of such chemical substitutes and the means of application will ever supplant water in the extinguishment of fires which have developed beyond the incipient stage. One possible exception to this is the use of foam solution, which consists principally of water, in the extinguishment of large oil fires. In order that we may understand the practical value of portable extinguishers, we must have some conception of the characteristics of the various types of fires upon which they may be used.

Oxidation

Oxidation, the chemical combining of other substances with oxygen, takes place in several ways. Slow oxidation is going on all the time. It is the natural tendency of all things to turn to dust. When iron rusts, when copper turns green, when lead or aluminum loses its surface luster and becomes dull gray, each is oxidizing. Chemically, this is the same process as burning. Iron rust is essentially similar to the slag produced by burning iron in oxygen. When paper turns yellow with age, when lumber loses its fresh whitish look and become dark gray, the chemical change which has taken place is practically the same as the charring which fire produces. But this change takes place slowly over a long period of time, instead of quickly. The heat oxidation always generates is, in these slower processes, dissipated and carried off by the air in a very small, constant trickle through days, months or years, so that at no time is there enough heat present to remind us of fire.

In fast oxidation (combustion or burning), this entire process is condensed into a few seconds. Its effects are thus very marked and noticeable, temperatures of several hundred degrees being produced, because the heat is generated so much faster than it can be carried away. Since oxidation can and does take place all the time, there must be a reason why it takes the form of slow oxidation rather than of fast oxidation or burning. The reason for this is found in the temperature of the materials subject to the oxidation. Chemical action in general is stimulated by high temperature. Combustion, or fast oxidation, will take place in any substance only when the temperature of the substance is at, or beyond, a certain point. This point varies according to the substance involved.

Combustion can be suppressed by cooling or lowering the temperature of the burning substance to below the "temperature of combustion," by excluding the supply of oxygen from the atmosphere in contact with the burning substance, by removing the combustible material, or by a combination of these means. In the

discussion of portable fire extinguishers we are mainly interested in the cooling of the burning material, and in the exclusion of the oxygen supply.

Spontaneous Ignition

Heat and ignition of a combustible material due to internal chemical action rather than to applied flame, spark, radiation, a hot surface, or friction are known as "spontaneous." The process is known as "spontaneous heating" if the ignition point is not reached, and "spontaneous ignition" or, popularly, "spontaneous combustion," if ignition occurs.

In general, spontaneous heating starts with a slow oxidation which generates heat. Increased heat accelerates chemical action, and the process proceeds at an increasing rate until the ignition temperature may be reached. Except in the case of a few substances subject to rapid ignition, the process is relatively slow, and ignition may be a matter of hours, days or even months. In the case of ordinary materials subject to spontaneous ignition, heating occurs only under a combination of favorable circumstances. There must be sufficient air supply for oxidation but with ventilation sufficiently restricted to prevent the carrying away of the heat generated by the oxidation. Such conditions are found in large masses of material not too tightly packed. The material must be finely divided so as to present a relatively large surface exposed to oxidation. With many materials, the presence of some moisture promotes spontaneous heating, but heating does not occur if the material is wet beyond a certain point. Some materials which are not considered subject to spontaneous heating when in pure form may heat spontaneously if there are small amounts of impurities present. The initial temperature may be an important factor, as some materials which at ordinary temperatures show no tendency to spontaneous heating may heat when subjected to higher temperatures, as during exceptionally hot summer weather or when stored near sources of heat, such as boilers.

For the purpose of classifying substances subject to spontaneous ignition, they may be divided into groups as follows:

Group 1. Substances not themselves combustible, but which may cause ignition in other materials near them. Calcium oxide (unslaked lime) is the outstanding member of this group. Such substances should be kept dry and away from combustibles.

Group 2. Substances having ignition points below ordinary temperatures. Examples of this group are sodium and potassium in the presence of water; turpentine and ammonia in the presence of chlorine; hydrogen and chlorine in the presence of light; and the hydrides of phosphorus and silicon in the presence of air. Included in this group also are substances which when alone are not acted upon by oxygen but which may simultaneously undergo oxidation with another compound which is capable of oxidation at ordinary temperatures.

Group 3. Substances which may undergo sufficient oxidation at ordinary temperatures to reach their ignition point. Included in this group are easily oxidized vegetable oils, fats, certain metals in a finely divided state, metallic sulphides, charcoal, and coal.

Group 4. Substances of an organic combustible nature subject to bacterial action. Agricultural products such as hay and grain are members of this group.

Classification of Portable Fire Extinguishers

In order to express the relative fire extinguishing potential of portable fire extinguishers, the following classification plan has been established.

Classification of Fires

For all practical purposes, fires are classified as:

(1.) *Class A Fires*: Fires in ordinary combustible materials where extinguishment is best secured by using a water or water solution extinguisher (wet to cool; soak to stop smouldering) or by coating the burning combustibles with a multipurpose dry chemical.

(2.) *Class B Fires*: Fires in flammable liquids, greases, etc., where a blanketing-smothering or a flame-interrupting effect is essential.

(3.) *Class C Fires*: Fires in energized electrical equipment where the electrical nonconductivity of the extinguishing media is of first importance. (Where electrical equipment is de-energized, extinguishers suitable for use on Class A or B fires may be employed effectively.)

(4.) *Class D Fires*: Fires in combustible metals, such as titanium, zirconium, sodium, potassium, etc., which require special extinguishing agents.

(5.) *Other Fires* involving certain combustible metals or reactive chemicals require, in some cases, special extinguishing agents or techniques.

Rating of Fire Extinguishers

Based upon the preceding classification of fires and also upon fire extinguishment potentials as determined by physical testing of fire extinguishers by Underwriters' Laboratories, Inc., ratings have been established for portable fire extinguishers.

These ratings consist of a NUMERAL, a LETTER or combinations thereof. They appear on the labels affixed to the extinguishers listed by Underwriters' Laboratories, Inc., and Underwriters' Laboratories of Canada. These NUMERALS and LETTERS connote the following:

(a). In the case of extinguishers suitable for use on Class A fires, the NUMERAL is indicative of the approximate relative

fire extinguishing potential of various sizes of the different suitable extinguishers available, e.g., a 4-A extinguisher can be expected to extinguish approximately twice as much fire as a 2-A extinguisher.

(b). In the case of extinguishers suitable for use on Class B fires, the NUMERAL is also indicative of the approximate relative fire extinguishing potential of various sizes of the different suitable extinguishers available, and in addition, the NUMERAL is an approximate indication of the square-foot area of deep-layer flammable liquid fire which an average operator can extinguish, e.g., a 10-B unit can be expected to extinguish 10 square feet of deep layer flammable liquid fire when used by an average operator.

(c). In the case of extinguishers suitable for use on Class C fires, no NUMERAL is used since Class C fires are essentially either Class A or B fires involving energized electrical wiring and equipment. The size of the different suitable extinguishers installed should be commensurate with the size and extent of the area involving the electrical hazard or containing equipment being protected.

(d). The LETTER or LETTERS refer to the class or classes of fire on which the use of the particular extinguisher is (are) most effective for fire extinguishment.

Examples:

Foam extinguisher, rated 2-A, 4-B. This extinguisher should extinguish approximately twice as much Class A fire as a 1-A extinguisher, and four times as much Class B fire as a 1-B extinguisher. Also, the extinguisher should extinguish a fire in a deep-layer flammable liquid, such as a dip tank having a surface area of 4 square feet, when used by an average operator.

Dry chemical extinguisher, rated 6-B,C. This extinguisher should extinguish approximately six times as much Class B fire as a 1-B unit and should successfully extinguish a deep-layer flammable liquid fire of 6 square foot area when used by an average operator. It also is safe to use on fires involving energized electrical equipment.

A multi-purpose extinguisher, rated 4-A,16-B,C. This extinguisher should extinguish approximately four times as much Class A fire as a 1-A extinguisher, 16 times as much Class B fire as a 1-B extinguisher and a deep-layer flammable liquid fire of 16 square feet area when used by an average operator, and it is also safe to use on fires involving energized electrical equipment.

Classification of Methods of Propulsion

To be of any practical value these extinguishing agents must be provided with suitable means of expelling them from their storage compartments and of propelling streams to the seat of the fire in an effective manner. Methods employed in portable fire ex-

tinguishers for accomplishing this purpose are classified as follows:

1. Hand generated pressure—(mechanical hand pumps)
2. Internally generated pressure—(pressure created as product of chemical reaction taking place within)
3. Stored pressure—(gas cartridge or confined air pressure)

Principal Types of Extinguishers

1. Water Solution Extinguishers (Pressurized)

(a) *Plain Water Extinguishers.* Extinguishers for fire department use are usually of 2½-gal. capacity in which plain water is the extinguishing agent. The water is discharged by the pressure of carbon dioxide gas stored in a special sealed cartridge, or by the expellant gas stored in the same container as the water.

Dependent upon the model, the expellant gas is released from a cartridge by either inverting the extinguisher and bumping it on the floor to puncture the gas-retaining seal or by squeezing a valve lever to release gas stored in the same chamber with the water. The maintenance requirements of the pressurized plain water extinguisher requires annual weighing of the carbon dioxide cartridge or, in the stored pressure type, the checking with a gauge to determine if it has lost pressure, and an inspection of the liquid level to insure that the extinguisher is properly filled. In addition the hose and nozzle should be checked to insure that they are not obstructed. In weighing the cartridge, if the cartridge has lost ½ ounce or more, it should be replaced with a full cartridge.

(b) *Calcium Chloride Solution Extinguishers.* These solution extinguishers are designed for use at temperatures as low as -40°F. They should be charged only with the calcium chloride solutions prepared from charges furnished by the manufacturers. The expelling agent is gas from carbon dioxide cartridges. The extinguishers are operated by inverting and bumping on the ground. The most common size of this extinguisher is 2½ gallons.

Maintenance of this extinguisher is similar to that of the plain water type of extinguisher. Directions for charging and maintenance of the extinguisher are on its nameplate and should be carefully followed.

(c) *Soda and Acid Extinguishers.* The soda and acid extinguisher is the commonest type of water solution extinguisher in which internally generated pressure is used to expel the water. The 2½-gallon size is most common. The chemicals used are sodium bicarbonate (baking soda) and sulphuric acid. The sodium bicarbonate is dissolved in water and this solution constitutes the extinguishing agent. The extinguishing value of the stream is that of an equal quantity of water. The sulphuric acid is in concentrated form and is contained in a glass bottle held in a cage in the top of the extinguisher. The glass bottle is closed by means of a lead or ceramic stopper which fits loosely so that it will readily

drop out when the extinguisher is inverted. Inverting the unit permits the acid and the sodium bicarbonate to mix and react chemically to produce carbon dioxide gas in sufficient quantity to build up pressure and expel the water solution from the extinguisher.

These extinguishers should be recharged annually as well as immediately after use. In recharging, all parts should be washed thoroughly with water and the water drained through the hose. It is desirable to give new men, if any, a chance to operate the extinguisher when emptying it for recharge so as to acquaint them with the proper method of operation. Annual recharge is specified because the chemicals used deteriorate with age. The sodium bicarbonate solution slowly decomposes, releasing carbon dioxide, particularly when exposed to abnormally high temperatures. The sulphuric acid tends to absorb moisture from the air, becoming diluted and eventually overflowing. Also, some of the acid may be spilled during rough handling of the extinguisher. Annual recharging is considered essential to provide reasonable assurance that the extinguisher is in proper operating condition.

In making up the charge for the extinguisher, the sodium bicarbonate should be dissolved in lukewarm (not hot) water outside the extinguisher and then poured into the extinguisher in accordance with the instructions of the extinguisher manufacturer.

Protection of these extinguishers against freezing should be provided.

The use of anti-freeze solutions in soda-acid extinguishers is not practicable because any anti-freeze agent is likely to cause corrosion, interfere with the chemical reaction, or, where the anti-freeze agent is combustible, reduce the extinguishing action. Furthermore, even if an otherwise suitable anti-freeze agent were available, soda-acid extinguishers would be of questionable value at low temperature owing to the retarding of the chemical reaction due to cold.

(d) *Loaded Stream Extinguishers.* The alkali-metal salt solution type of extinguisher is known as the "loaded stream" extinguisher and although the exact composition of the charge is a trade secret, it is known that potassium salts form a portion of the mixture. The effect of the loaded stream solution on fire differs from that of other extinguishing agents. On Class "A" fires the stream extinguishes the flame rather suddenly and there is a pronounced fire-retarding effect. This type of extinguisher is effective on small Class "B" fires. There is no smothering vapor produced to blanket the fire, but apparently there is a chemical reaction tending to inhibit oxidation. Best results are obtained by directing the stream on the side of the pan or vat and above the liquid surface.

The loaded stream type of extinguisher is obtainable either in a design with a carbon dioxide cartridge for expelling the solution or in a design using a chemical reaction between an acid and the

alkali-metal salt solution. The latter type should be discharged annually and the extinguisher thoroughly washed out with water, draining the water through the hose.

(e) *Foam Solution Extinguishers*. Foam extinguishers expel a foam of carbon dioxide bubbles through a hose and nozzle and this foam covers burning material, particularly flammable liquids in dip tanks or vats, excluding oxygen and thereby extinguishing the fire. This extinguisher is most commonly found in the 2½-gallon size. Sodium bicarbonate (baking soda) and a foam-stabilizing agent are dissolved in water and placed in the large outer container and an aluminum sulphate solution is placed in the smaller inner container. When the extinguisher is inverted, the two solutions mix to produce carbon dioxide gas, which serves not only to force the liquid from the extinguisher but also to form bubbles which are toughened by the foam-stabilizing agent.

The quality and quantity of foam produced by the extinguisher depend upon the ingredients, the care taken in mixing the charge, and the temperature at which the extinguisher is operated. At ordinary room temperature, a 2½-gallon extinguisher will produce 18 to 20 gallons of foam. To secure satisfactory results, foam charges should be obtained only from the extinguisher manufacturer.

These extinguishers should be recharged annually. After discharging, all parts of the extinguisher should be thoroughly washed with water, draining the water through the hose. It is very important that the solutions composing the charge be mixed thoroughly outside the extinguisher and exactly as the extinguisher manufacturer recommends in the instructions furnished on the extinguisher nameplate. No attempt should be made to add other ingredients to the solutions, as this may reduce the effectiveness of the extinguisher or cause corrosion of the shell.

Protection of these extinguishers against freezing should be provided. Overheating should be avoided owing to possible deterioration of the charge due to excessive heat.

No chemicals should be added to the charge to depress the freezing point because of probable corrosion and interference with the chemical reaction as in the case of soda-acid extinguishers.

Foam is best used on flammable liquids contained in tanks or vats, or where the flammable liquid may have spilled but is not flowing. It is less effective where the smothering layer of foam may be broken by the flow of the underlying flammable liquid and may be completely ineffective on fires in flammable liquids flowing from broken lines. When applied on fires in flammable liquids in depth, such as in a tank, it is necessary to direct the stream of foam against the inside of the tank so that it will not plunge into the burning liquid, but will flow over the surface. Otherwise, the foam will rise to the surface with the flammable liquid burning on it and may be broken down rapidly, allowing the fire to go beyond the

control of first aid equipment. The method of trying to avoid this difficulty by directing the stream of foam from a point at a distance from the fire so as to allow the foam to drop lightly on the surface of the burning liquid is effective only when this distance is not so great as to result in a breaking up of the foam stream into "drops," since the heat of the flames will break down the foam much more rapidly when the foam is in the form of drops. The operator should, if possible, walk around the fire while directing the stream so as to reduce more quickly the intensity of the flames and so as to reduce the amount of breakdown of the foam during its application.

The foam produced by these extinguishers is not suitable for fires involving ethers, alcohol, esters, acetone, lacquer thinners, or carbon disulphide.

Foam may cause boiling over if applied to hot flammable liquid where the body of the liquid is at temperatures of 250°F. or over.

2. *Carbon Dioxide Extinguishers.* This type of extinguisher contains liquid carbon dioxide under a pressure of 800 to 900 pounds per square inch at normal room temperature. The extinguisher consists basically of a pressure container, a valve for releasing the carbon dioxide, and a means of effectively applying the carbon dioxide on the fire. A tube extends from the valve to the bottom of the extinguisher so that only liquid carbon dioxide reaches the discharge horn until about 80 per cent of the contents have been discharged (at normal temperatures), after which gaseous carbon dioxide is discharged.

The discharge device for these extinguishers consists of a "horn" at the closed end of which is an orifice from which carbon dioxide is expelled. The horn surrounds the jet of carbon dioxide at the point at which the velocity is very high and prevents air from being entrained to dilute the stream and reduce its effectiveness. By the time carbon dioxide stream has reached the open end of the horn, the velocity has been reduced to a point at which no important amount of air is entrained. The horns are either directly attached to the extinguisher valves or attached through swing joint connections on extinguishers of capacities up to 5 lbs., but on larger sizes the horn is attached to the end of a hose capable of withstanding high pressures.

Carbon dioxide is essentially nonconducting and, accordingly, these extinguishers are suitable for use on fires in electrical equipment when they are provided with horns made of nonconductive material.

The expansion of the liquid carbon dioxide as it escapes from the orifice at the closed end of the horn chills it to low temperatures so that approximately 30 per cent of the liquid carbon dioxide is converted into a solid (carbon dioxide "snow" or "dry ice"). Although the cooling effect of this snow unquestionably is a factor in preventing flashback when the fire is small, it is negligible com-

pared with that of water and is unimportant in the extinguishing of fire compared with the smothering action of the carbon dioxide.

Carbon dioxide is an odorless, tasteless, colorless, inert gas that will not support combustion. The best extinguishing results are obtained by applying the discharge as close to the fire as possible, first at the near edge of the fire, moving the discharge horn slowly from side to side, slowly progressing forward as the flames are extinguished. One of the advantages of this type of extinguisher is that there is no residue from the extinguishing agent.

Although the toxicity of carbon dioxide is practically negligible, it may cause suffocation of persons exposed to high concentrations for extended periods of time. Such a condition would rarely be encountered in the use of portable extinguishers.

Carbon dioxide extinguishers should be weighed at least semi-annually to insure that they are adequately filled. If the weight loss is in excess of 10 per cent of the rated capacity of the extinguisher, the extinguisher should be recharged, either by sending it to the manufacturer or his authorized agent or by means of refilling equipment available in the department.

3. Dry Chemical Extinguishers for Class B and C Fires.

Approved hand fire extinguishers are made in many sizes having capacities up to 30 pounds of dry chemical. The fire extinguishing agent used is a specially treated material suitable for use on Class B and C fires in dry powder form with components for producing free flow and water repellency.

Extinguishers are designed to be carried to the fire and, to be used, must be operated in accordance with instructions which are prominent on the extinguisher. In the case of cartridge-operated extinguishers, release of the gas in the cartridge pressurizes the dry chemical chamber and expels the dry chemical. The discharge is controlled by a shutoff valve. With a pressurized dry chemical extinguisher, both the dry chemical and expellant are stored in a single chamber and the dry chemical may be expelled by opening the extinguisher valve. Release of the extinguisher valve provides a shutoff feature. In either case, operation expels a cloud of dry chemical from the nozzle.

On fires in flammable liquids, and electrical equipment, the discharge should be directed at the base of the flames. Best results are obtained by attacking the near edge of the fire and progressing forward moving the nozzle rapidly with a side-to-side sweeping motion.

Some extinguishers have relatively high velocity nozzles and to prevent splashing when used on depths of flammable liquid, care should be taken to direct the initial discharge from a distance not closer than 6 to 8 feet. This warning is usually prominently marked on the extinguisher name plate.

On the surface fires involving textiles, the discharge should be directed at least 3 or 4 feet above the flame from a distance of

8 to 10 feet. By this procedure, the dry chemical provides a coating on surface areas ahead of flash fires which tends to retard the progress of the fire. After this application, the discharge can be directed at the initial fire without the danger of spreading the fire by blowing burning particles about.

The discharge should be applied to the burning surface even after the flames are extinguished, to prevent possible reflash by coating the hot surfaces and any glowing materials present.

These extinguishers are effective on fires in small quantities of flammable liquids, greases, etc., in open vessels or on floors, etc., i.e., on Class "B" fires, where the cloud of chemical may be employed to separate the flame from the burning surface.

They are effective on incipient fires in electrical equipment, i.e., on Class "C" fires where a nonconducting extinguishing agent is of importance.

Dry chemical extinguishers as covered in this section are not effective on deep-seated fires in ordinary combustible material, (Class A fires), but may be of value for surface fires in small quantities of such material. Surface fires in textile and paper operations may be effectively controlled by these dry chemical extinguishers, but smoldering and sub-surface fires may still persist. Therefore, water in some form preferably spray, shall be provided to extinguish residual fire.

In using extinguishers of this type, consideration should be given to any possible hazard which may be created by reduction in visibility due to the cloud of dry chemical.

This extinguisher does not need to be protected against freezing.

Extinguishers shall be kept fully charged at all times. Visual inspection, weighting and checking pressure are the methods of determination, depending on type.

In the case of cartridge-operated extinguishers, the dry chemical charge may be checked by visually checking the level and the cartridge weighed to determine whether it is fully charged. Certain extinguishers are provided with a cartridge incorporating a pressure gauge which will indicate whether the cartridge has maintained its contents.

In the case of pressurized extinguishers, weighing is the method of determining whether the extinguisher is fully charged with dry chemical and examination of the pressure gauge indicates whether or not the extinguisher is properly pressurized. Certain pressurized extinguishers do not incorporate a pressure gauge, and these are checked by weighing only.

Extinguishers shall be refilled immediately after use, even though only partially discharged. Before recharging, hose shall be cleaned of all dry chemical.

At least semi-annually, all cartridges shall be removed and weighed on an accurate scale to detect loss of contents by leakage.

A replacement cartridge shall be provided if the loss of weight is in excess of that permitted by the instructions on the extinguisher name plate. The cartridges which are provided with a gauge and the pressurized extinguishers shall be examined to determine whether the pressure indication on the gauge is within operable range.

4. Dry Chemical Extinguishers for Class A, B and C Fires (Multi-Purpose Type).

Extinguishers suitable for use on Class A, B and C fires are made in sizes having capacities up to 30 lbs. The fire extinguishing agents used are specially treated materials, in dry powder form, with additives for producing free flow and water repellency.

Extinguishers are designed to be carried to the fire and, to be used, must be operated in accordance with instructions which are prominent on the extinguishers. In the case of cartridge-operated extinguishers, release of the gas in the cartridge pressurizes the dry chemical chamber and expels the dry chemical. The discharge is controlled by a shutoff valve. With a pressurized dry chemical extinguisher, both the dry chemical and expellant are stored in a single chamber and the dry chemical may be expelled by opening the extinguisher valve. Release of the extinguisher valve provides a shutoff feature. In either case, operation expels a cloud of dry chemical from the nozzle.

On fires in ordinary (Class A) combustibles, the discharge should be directed at the burning surfaces so as to cover them with chemical. When the flames have been extinguished, the chemical discharge should be directed on any glowing areas. Careful watch should be maintained for any hot spots that may develop and additional agent applied to those surfaces as required to coat them thoroughly with the extinguishing medium.

These extinguishers are effective on incipient fires in ordinary combustible materials, i.e., on Class A fires. The extinguishing agents adhere to heated surfaces and thus coat the combustible materials. Extinguishment results from agent retained on the surface of the combustible material rather than by quenching as with water type extinguishers.

They are effective on fires in small quantities of flammable liquids, greases, etc., in open vessels or on floors, etc., i.e., on Class B fires, where the cloud of chemical may be employed to separate the flames from the burning surface.

They are effective on incipient fires in electrical equipment, i.e., on Class C fires where a nonconducting extinguishing agent is of importance.

In using extinguishers of this type, consideration should be given to possible hazard which may be created by reduction in visibility due to the cloud of dry chemical.

This extinguisher does not need to be protected against freezing.

Extinguishers shall be kept fully charged at all times. Visual inspection, weighing, and checking pressure are the methods of determination, depending on type.

In the case of cartridge-operated extinguishers, the dry chemical charge may be checked by visually checking the level and the cartridge weighed to determine whether it is fully charged. Certain extinguishers are provided with a cartridge incorporating a pressure gauge which will indicate whether the cartridge has maintained its contents.

In the case of pressurized extinguishers, weighing is the method of determining whether the extinguisher is fully charged, and examination of the pressure gauge indicates whether or not the extinguisher is properly pressurized. Certain pressurized extinguishers may not incorporate a pressure gauge, and these are checked by weighing only.

Extinguishers shall be refilled immediately after use, even though only partially discharged. Before recharging, hose shall be cleaned of all dry chemical.

At least semi-annually, all cartridges shall be removed and weighed on an accurate scale to detect loss of contents by leakage. A replacement cartridge shall be provided if the loss of weight is in excess of that permitted by the instructions on the extinguisher name plate. The cartridges which are provided with a gauge and pressurized extinguishers shall be examined to determine whether the pressure indicated on the gauge is within the operable range.

RESCUE AND FIRST AID EQUIPMENT

General Statement

Devices for the protection of fire fighters against the irritant and poisonous nature of the noxious and toxic gases of various kinds encountered in fighting fires will be the first to be discussed under this group. Modern fire department practice recognizes that the use of such devices is an **ESSENTIAL FEATURE OF EFFECTIVE FIRE FIGHTING**. The primary value of these devices lies in their prevention of injury or death to fire fighters, but they are also valuable in reducing fire loss since they enable the men to penetrate to the seat of the fire and to hold their positions without being driven away. When the fire fighters are equipped with such devices, less ventilation of the structure on fire is required, and that ventilation which is necessary can be performed much more readily. These devices also enable the fire fighters to perform rescue operations involving the saving of lives which might otherwise be lost.

The most common of the poisonous gases met in fighting fires is carbon monoxide, that insidious gas which is the bane of all fire fighters. It is odorless, colorless, tasteless, flammable, explosive and toxic. It is slightly lighter than air having a density of .97. Carbon monoxide is present in varying degrees at practi-

cally all fires. Cellar and basement fires, and those involving oil, or material in compact form, are producers of large quantities of carbon monoxide. Since such fires are difficult to ventilate it is obvious that some form of protection must be provided against carbon monoxide gas. Sources of other gases requiring protection are mechanical refrigeration and leakage or spilling of the various chemicals met in industry. Mechanical refrigerating systems are found in many stores and restaurants and in a great many apartment houses. Many of these systems contain ammonia or sulphur dioxide, both toxic refrigerants. Although these gases through their distinctive odors give persons adequate warning of their presence so that such persons can escape before dangerous concentrations of the gases are reached, fire service may require that entrance be made by fire fighters into places where such dangerous concentrations exist.

While some of the devices for protection mentioned above will give respiratory protection in atmospheres containing hydrocyanic acid gas and other similar gases having a cyanide base such as cyanogen, etc., used mostly in fumigating operations, they do not give adequate protection when high concentrations of such gases are encountered, inasmuch as these gases are absorbed through the unprotected skin of the body and in that manner will induce poisoning and, in extreme cases, death. The irritating effects of these gases are not felt when they are being absorbed through the skin. Therefore, a person who has been in a place where one of these was present may have absorbed sufficient gas to cause irreparable damage to his body without his even having been aware of his danger. The action of these gases is to stop the flow of blood in the body.

A common sense precaution urged upon all fire departments responding to an alarm for a building in which fumigation operations are being conducted is to perform complete and thorough ventilation immediately. If entrance must be made to such premises, it is recommended that such entrance be made without the use of masks unless the body is completely protected against such gas, as the use of such masks will only give their wearers a false sense of security. Hydrocyanic acid gas is readily detected by the distinctive odor of bitter almonds.

All Service Type Gas Masks

This mask consists of an adjustable head harness, tight fitting "All Vision" facepiece with non-fogging "All Vision" lenses, exhalation valve, flexible corrugated tube, external check valve, special gas filtering canister and canister harness so arranged that all the air breathed comes through the canister which contains substances for removing poisonous gases. The Type S, as approved by the U. S. Bureau of Mines, gives protection against all poisonous gases, in concentration of 2% or less, which fire fighters are likely to encounter, including carbon monoxide.

A. Limitations on Use of All Service Type Gas Mask

These gas masks, in spite of their being called "All Service" masks, have limitations which should be well understood prior to their use by all fire fighters if they are to use such masks with safety.

1. Such masks are utterly useless in atmosphere deficient in oxygen. This condition is found in closely confined spaces where upon fire breaking out, the available oxygen supply of the air therein is soon eaten up; in tanks which have recently held readily volatile material, such as gasoline; in sewers and manholes in which gases may accumulate and where there is very little ventilation; or where carbon dioxide or other gases have seriously diluted the oxygen supply of the air.

2. Where there are high concentrations of poisonous gases in the atmosphere, the materials in the canisters are rapidly used up, owing to the rapid chemical union of the gases and the ingredients in the canister, and considerable heat is developed. This heat may be readily recognized by the warmth of the air breathed and also by the heating of the canister itself.

3. Water coming in contact with the ingredients in the canister causes them to cake up and thus lose their effectiveness.

B. Component Parts of All Service Type Gas Mask

1. Adjustable Head Harness. Consists of web or rubber head bands, easily adjusted for head size, which are connected to facepiece by swivel buckles so that no metal touches the face. The harness is designed so as to assure wearing comfort with complete absence of "pressure points." Buckles are placed so as not to interfere with the wearing of fire fighters' helmets. The harness is used to bring the mask tightly against neck, cheeks and forehead, without leakage.

2. "All Vision" Facepiece. Permits maximum useful vision at all seeing angles, with extra large non-fogging "All Vision" lenses contoured at sides. The large-area lenses are made of strong, replaceable, shatter-proof, laminated safety glass. Built-in-fog-proof construction insures clear vision at all times by conducting dry incoming air over the lenses, thus preventing the accumulation of moisture or fog. Readily fits any face with perfect gas tight seal; minimum dead air space cuts down rebreathing of exhaled air. Facepiece can be disinfected at will, without being harmed.

3. Exhalation Valve. Simple and, for all practical purposes, foolproof. Strategically placed in direct path of exhaled air and guarded against deformation, it permits free head movement in all directions and has no seat to become corroded or get out of alignment. It is constructed of rubber and is normally in the closed or collapsed position except when exhaling air. If, when the mask is put on, the facepiece tends to pull away from face and breathing

is difficult, this valve should be tested with fingers to make sure it is not obstructed.

4. Flexible Corrugated Tube. Non-collapsible, light and flexible, permits free head movement. Ample in length and made of materials specially selected to withstand water and acids.

5. External Check Valve. This valve is threaded at both ends to permit easy, positive connection between canister and breathing tube. It prevents exhaled air from entering the canister, and provides an effective seal against entry of any moisture into the top of the canister during either use or storage. It closes automatically after inhalation regardless of the position of the canister. It also guards the canister against moisture when facepiece and tube are being cleaned.

6. Window-Cator Canister. The front of the canister contains a small round window with a color indicator which immediately tells wearer when the canister should be discarded because of its loss of effectiveness against carbon monoxide, giving the wearer an extra measure of safety. The two color panels visible through the little window tell the wearer at all times the effectiveness of the canister against carbon monoxide. The left panel (facing the window) is dark blue. The right panel is a lighter blue. When the left panel turns a matching light blue, it is a positive indication that enough moisture has penetrated the "Hopcalite" to render it ineffective against carbon monoxide. Continued use causes the indicator panel to turn pink. Do not use a canister if colors match or if the indicator panel is pink.

The purpose of each of the materials in the canister may be enumerated as follows:

1. Cellulose Filter for filtering toxic dusts, fumes, mists, fogs, and smokes including radioactive particles.

2. Layer of Activated Charcoal for absorbing Organic Vapors.

3. Caustite for absorbing Acid Gases.

4. Molecular Sieve which acts as an absorber of Ammonia; also as a Dryer, preventing moisture from reaching "Hopcalite."

5. Window Indicator warns user when cannister is no longer effective against CO.

6. "Hopcalite" which acts as a Catalyst to convert Carbon Monoxide (CO) to Carbon Dioxide (CO₂) by uniting the Oxygen (O) in the air to the Carbon Monoxide (CO) thus forming Carbon Dioxide (CO₂) which is a relatively harmless gas. "Hopcalite" also has considerable absorbing powers for organic vapors and acid gases.

7. Pure Anhydrous Calcium Chloride, which acts as a Dryer, preventing moisture from reaching "Hopcalite."

8. High Efficiency Filter for dusts.

9. Spring holding chemical layers in positions.

C. Directions for Use of All Service Type Gas Mask

Remove and discard the top seal and stopper from one of the canisters and assemble the mask. Do not remove the plastic coated tape at bottom of canister until after "Leakage Test," as hereinafter described, is made.

Suspend the mask on the chest by means of the neck strap. Next tighten the body strap so that the canister is drawn snugly against the chest.

Grip the facepiece where the head straps are connected, insert the chin well into the lower part of the facepiece, and pull the head straps back over the head. The head straps should lie flatly against the head and may be tightened or loosened to fit by means of the buckles. When tightening the straps, the bottom straps should be pulled first and working to the top or head strap. If mask does not then fit snugly, the same procedure must be repeated. The facepiece should rest firmly and comfortably against the face at all points.

Next, inhale deeply. The facepiece should draw tightly against the face without leakage, and there should be no leaks in any other part of the equipment. This is the "Leakage Test" and "Must" be made every time the mask is used. If no leaks are detected, remove the tape at the bottom of canister. The mask is now ready for use.

NOTE: Do not discard the bottom tape, because it can be replaced on the bottom of the canister after use. This will help prolong the life of the canister by keeping moisture from entering through the bottom opening.

The canister must not under any conditions be worn for more than 2 hours' continuous or intermittent use. A record must be kept of the time the canister is in use. However, if a trace of any fumes should be noticed coming through the canister or if breathing through the canister becomes noticeably difficult at any time, before the expiration of 2 hours' use, the area must be evacuated immediately by the person wearing the mask and the canister replaced.

When the seals on the canister are broken, the date must be recorded on the canister and the canister must be discarded at the expiration of ONE YEAR from that date even if it is not completely used up.

Keep lens in the facepiece clean. Examine the mask parts including the rubberized parts, connections, and fittings periodically to insure that they are in good order.

Canister Shipping Instructions. Do not break the seal on a canister till the latter is ready for use. The closed seal is the only method of indicating that a canister is fresh.

D. All Service Type Mask With Speaking Diaphragm Facepiece.

Facepiece equipped with a micarta diaphragm that is impervious to acid, heat or corrosive fumes. This diaphragm trans-

mits speech naturally and without distortion. It assures communication between men in gas or smoke filled air.

Other Masks

Gas Mask—Telephone Equipment. With this device, a fire fighter in a remote smoke filled location can talk with those outside of his sphere of operation. Precious minutes are saved in getting valuable information to the Chief regarding conditions within a building, because the fireman can report promptly as to the exact location and extent of the fire, the presence of dangerous, inflammable materials, the location of stairways, elevator shafts, etc., and other vital factors that influence the method of fighting the fire. The wearer of the mask can get in close to the fire and direct the streams to the best advantage. Rescue squads can be used most effectively and promptly. Orders to men on the top of a building or other location are transmitted clearly and speedily, and should the wearer be in danger, he can immediately make known his location and predicament.

Two-way communication is carried on between wearer and someone at the fresh air base without the use of batteries or outside connections. The voice fluctuations in the magnetic circuit of the transmitter generate a minute electric current (too small to be measured with instruments), which is transmitted to the receiver where it is reconverted into magnetic fluctuations and reproduces the spoken voice. Receiver is so designed as to give a high degree of reception, even where surrounding noises are loud. This high degree of reception is a valuable feature in emergency and rescue work.

Standard equipment is usually provided with 100 feet of telephone cord connecting the two transmitter-receivers.

This equipment may be utilized with the various types of masks in use by fire departments.

Respiratory Protective Equipment Independent of Surrounding Atmospheres. Special masks have been developed to provide respiratory protection in atmospheres containing concentrations of harmful gases too high for the safe use of the All Service type masks and in atmospheres where the oxygen content is below the minimum limit necessary to sustain life. These special masks are the Self-Generating Oxygen Mask, the Stored Compressed Air or Oxygen Mask, and the Fresh Air Hose Mask.

Self-Generating Oxygen Mask. This equipment consists of: an "All Vision" gas mask type facepiece with extra large contoured lenses; exhalation and inhalation breathing tubes connected to a canister containing an oxygen evolving chemical; a breathing bag made of heavy Neoprene; and a harness designed for maximum wearing ease.

It is a self-contained breathing circuit operating independently of the outside air. It employs a replaceable canister containing

a chemical which, upon contact with the moisture in the exhaled breath of the wearer of the mask, evolves a plentiful supply of oxygen for breathing requirements and at the same time absorbs the exhaled carbon dioxide and moisture, thus affording complete respiratory protection for the wearer in atmospheres containing concentrations of harmful gases and in atmospheres deficient in oxygen.

The flow of the exhaled breath from the facepiece passes through the exhalation valve and tube to the canister, where the carbon dioxide in the breath is absorbed and the moisture content reacts with the chemicals to evolve pure oxygen to meet breathing requirements. The evolved oxygen flows upward through the canister and into the breathing-bag reservoir where it is cooled. It then passes through the inhalation tube to the wearer's facepiece.

How to operate the self-contained oxygen mask: After the apparatus is put on and the harness straps properly adjusted, the tear-off cap and the metal and cardboard discs are removed from the canister, which is then inserted fully into the canister holder, with the concave or ribbed side against the body. The canister should then be locked firmly into the chamber by turning the hand-wheel. The exposed copper foil in the neck of the canister is punctured in this locking operation. Set the timer by turning the pointer clockwise, making allowance for the time it will take to return to fresh air. Put on facepiece and adjust to a snug fit by means of the head straps. Next, grasp and squeeze the left breathing tube with the left hand while breaking the seal of the facepiece against the cheek with the fingers of the right hand. Inhale, release the facepiece, and exhale into the apparatus. Repeat this procedure of inhaling, releasing the facepiece and exhaling into the apparatus until the breathing bag is fully inflated. Depress the pressure relief valve and force the air from the breathing bag with the elbows. Reinflate the breathing bag once more, in the above-described manner, to activate sufficiently the chemicals in the canister. In most cases 15 breaths are required to get the proper chemical activity. If the canister has not begun to warm up (failure to warm up being evidence of insufficient chemical activity) inhale and exhale a few more times until the canister begins to warm up. *This must be done in fresh air.*

To check the complete apparatus for tightness, grasp the facepiece breathing tubes, squeeze them and then inhale. If the facepiece draws tight against the face, the facepiece seal is sufficiently tight. While still squeezing the breathing tubes with the hands, squeeze the breathing bag with the elbows. If the breathing bag does not deflate, the apparatus is tight. If a leak is indicated, the apparatus should be checked and the leak should be corrected before use.

The evolvment of oxygen in the self-generating oxygen mask automatically continues in accordance with breathing rates. The

appliance is equipped with an automatic timing device which rings a bell at the end of a pre-set time interval to indicate that the wearer should return to fresh air. Once the self-generating oxygen mask has been used, the canister must be replaced with a new one.

CAUTION. NEVER ALLOW ANY SUBSTANCE (ESPECIALLY OIL, WATER AND OIL, GASOLINE, GREASE, ETC.) TO ENTER THE NECK OF THE CANISTER, AS THE CHEMICAL IN THE CANISTER CONTAINS OXYGEN WHICH WILL CAUSE THE COMBUSTION OF ANY FLAMMABLE MATERIALS WITH WHICH IT IS BROUGHT INTO DIRECT CONTACT, ESPECIALLY IF SUCH MATERIALS ARE MOIST.

To dispose of a used or defective canister, punch a small hole in its front, back and bottom and place it in a container of clean water. The container should be deep enough so that the canister shall be at least three inches under the surface of the water and the surface of the water shall still be lower than the lip of the container. When the bubbling stops, any residual oxygen will have been dissipated and the canister will be expended. Pour the residual water, which is caustic, down a drain or dispose of it in some other suitable manner, and discard the canister.

This equipment has fog-free lens, weighs 13½ pounds and gives respiratory protection for 45 minutes.

Stored Compressed Air or Oxygen Mask. This mask provides the wearer with oxygen (or air) compressed in a cylinder for his breathing requirements and is controlled by a dependable demand regulator. The cylinder is carried on the back of the wearer of the mask. The complete assembly weighs approximately 32 lbs., and it supplies protection for the rated period of one-half hour under working conditions where gases, smoke or oxygen deficiency in confined atmospheres create respiratory hazards for the fire fighter. It is equipped with a non-fogging facepiece, a continuously indicating pressure gauge, and a harness.

Before entering a toxic atmosphere, the mask is put on and the valve on the cylinder opened, permitting oxygen to flow through the reducing and admission valve of the regulator to the facepiece.

Fresh Air Hose Mask. A respiratory device for providing a supply of fresh air from the outside atmosphere to the wearer who is working in a contaminated atmosphere, by means of a long hose. It consists of a facepiece similar to that used on gas masks, a flexible hose line, and an air intake funnel. Air may be supplied by its own normal flow, through the supply hose, or it may be provided by a special air pump connected at the outside end of the supply hose. The usual procedure when the supply hose is over 25 feet long is to pump the air supply. The pump supplies a continuous flow of fresh air to the operator wearing the fresh air mask.

Various types of pumps, including involute centrifugal blower, displacement, motor driven or a combination of hand and motor driven pumps, are used to supply air to the fresh air hose mask. Some of these pumps are provided with special connections so that two operators may be supplied with fresh air from a single source of supply.

Supply hose over 150 feet in length is seldom used. A rope of the same length as the supply hose should be attached to the wearer of the mask.

Shallow Water Diving Apparatus. This apparatus consists essentially of a small, high-pressure oxygen cylinder, and a Cardoxide canister for the removal of carbon dioxide from the exhaled breath. The equipment is supported by a well-fitting rubberized fabric vest divided into a large breathing reservoir and a flotation chamber.

In operation, oxygen is released manually from the cylinder into the breathing reservoir. A steady flow of oxygen may be maintained, or the supply may be bled in as required, according to preference. Oxygen flows from the breathing bag to a facepiece which is provided with large-area rectangular lens, a directional flow check valve, and flexible corrugated breathing tubes. The facepiece has a special inturned lip to assure positive water-tight seal under water. A manually operated pressure relief valve is also provided.

The breathing bag, which is constructed of sturdy, rubberized fabric, is carried over the shoulders. It supports the oxygen cylinder in front and the Cardoxide canister in back.

The oxygen cylinder has a capacity of approximately 7 cubic feet. When filled, it contains oxygen at a pressure of 1800 pounds per square inch. It is fitted with a diaphragm-type, high-pressure needle valve oxygen control which permits precise regulation of the oxygen supply. The Cardoxide canister for removal of carbon dioxide is sufficient for a full hour's operation, can be operated with efficiency at depths up to 35 feet, and can be readily removed and replaced by a fresh canister when necessary.

The flotation chamber of the vest is made of the same material as the breathing bag. Inflated by a carbon dioxide cartridge when quick ascent to the surface is desired, the vest may also be inflated orally through a tube.

Regulated buoyancy of the wearer of the shallow water diving apparatus is achieved by the use of removable weights attached to a leather belt at his waist.

Other Equipment

Life Net. Emergency landing net for rescuing fire victims who are trapped on upper floors of burning buildings and who have no other means of reaching safety.

Description of Life Nets. There are two types of life nets in common use.

1. *Rope Life Net.*

A circular net made entirely of rope, having a border of 4-inch rope. In the center there is a closely woven patch about one foot square. When open the rope life net has a diameter of approximately 9 feet.

2. *Canvas Life Net.*

Made up of a metal ring to which is attached, by approximately two dozen springs, a landing mat made of canvas and usually padded. The circular metal ring is divided and hinged so that it may be folded when carried on the apparatus. When the net is to be used, it is unfolded and the ring is locked into shape by sliding ferrules which cover over the hinged points. When the net is open, it has a diameter of approximately ten feet.

Use of Life Nets. In holding the net to catch a person, the men stand erect with left foot forward and hold the net at the level of their necks, each man holding the border rope or metal ring with both hands, palms upward. It is necessary to hold the net at this height so that there will be no danger that the person landing in net will come into contact with the ground through the force of his jump. Ten men should be used to hold the net, but this does not mean that fewer men cannot be employed under extreme emergency conditions. The third floor of a building is considered to be the highest point from which the life net is effective, but the net has been used to advantage in cases where greater heights were involved. In using the life net, the person jumping should try to land in a sitting position in the net. Men holding the net should always keep their eyes on the person jumping so that they may move the position of the net, when necessary, so as to bring it under the falling body of that person.

Life Gun. The life gun is a short, breach-loading musket that fires a blank cartridge to drive an arrow on which a ring, to which a light cord line is attached, slides. The arrow is placed in the barrel of the gun with the ring and line outside the muzzle. Ten feet of loose line lead from the ring to the inside of the coil of line which is laid on the ground. The gun is fired from the shoulder, and should be aimed a little above the point to be reached by the arrow. The direction and intensity of the wind should also be taken into consideration in aiming. The gun is used to shoot the arrow, with the line attached, to a person who can be reached in no other way. When the light line has been secured by such person, a rope is attached to this line by the men below. The person then hauls up the rope and uses it to effect his escape.

NOTE: The law provides: "A city or town having a fire department or having a fire district in which only the fire department thereof responds to the first alarm of fire therein shall provide and keep in good condition and ready for immediate use one or more of the fol-

lowing articles: A gun or other suitable device capable of throwing a projectile with a cord attached thereto over the top, or into the windows, of any building therein with all needful appliances for properly working the same; and a life net or jumping net strong enough to break the fall of a person jumping from the top story of such building. Such apparatus shall be taken to every fire occurring in a building over two stories in height. The engineers shall see that a sufficient number of firemen are regularly practiced and trained in the proper handling and use of the same."

Life Belt. A strong belt with a swivel hook attached, used when working on Pompier ladders or for rescue work. This broad canvas belt is put on with the buckles on the left side and the straps should be tightened by pulling them with the right hand.

When the hook of the belt is not in service, it may be kept to one side in the loop provided for the purpose. To use the belt, make the life line securely fast and take turns of the life line around the hook of the life belt, taking care to have the life line lead from the back of the hook.

To obtain the proper lead of the life line on the life belt hook, grasp the life line with the right hand, palm out, then hold the hook open toward you with your left hand, keeping this hand lower than the right hand, and take the turns over the hook away from you. When coming down a life line with another person, three turns should be taken around the hook with the life line.

Rapidity of descent may be controlled by grasping the rope with the right hand below the hook and holding the rope close to the body at the hip. (Never grasp the rope above the hook under any conditions.) Cloth gloves should be carried by men anticipating the use of the life belt for rope sliding.

Asbestos Suit. Designed particularly for use in fighting crash fires at airports and in fighting hot fires such as are encountered at oil refineries and similar places, but suitable for use under any fire conditions which require close range operations at hot fires. Complete suit is made of special asbestos cloth and consists of helmet, coat, pants, boots and gloves. Helmets are provided with heat resisting windows for clear vision.

The fire fighter's regular clothing should be worn under the asbestos suit to provide additional body protection. While asbestos will not burn, it will conduct heat. Therefore, the asbestos suit affords protection against flame for very brief intervals only. Precautions must be taken against getting the asbestos suit wet because the heat from the fire may be so intense as to turn the water in the suit to steam and scald the wearer of the suit. A life line should be placed on the wearer of an asbestos suit as an additional precaution.

Grapnel. Special device for locating and removing bodies immersed in water. Consists of a heavy spreader bar along which special grappling hooks are spaced at intervals. A drag chain is provided for towing the grapnel from boats.

Combustible Gas Indicator. Mechanical device for detecting the presence of flammable gases and vapors. Samples of the surrounding atmosphere are drawn through the indicator by use of a rubber syringe bulb and are automatically analyzed, the results showing on a visual indicator dial. This indicator dial is calibrated to show the percentage of flammable vapors in the atmosphere, their approach to the upper or lower explosive limits, and their range within those explosive limits. Some indicator dials are calibrated for specific gases and vapors. Other show the concentrations of numerous gases and vapors.

Body Wrapper. Special canvas or other fabric wrapper used for removing dead bodies. It may also be used in the rescuing of unconscious or injured persons to lower them from upper stories of buildings to the ground. The body is placed on the wrapper, the flaps of the wrapper are folded around the body and the heavy straps of the wrapper are made secure. A rope for hoisting and lowering is built into the wrapper.

Stretcher. A device used for carrying injured or unconscious persons. It is also used for carrying dead bodies. When it is not being used, the stretcher is kept in a compact carrying case which also contains sheets and blankets. A stretcher adaptable for fire department use is collapsible, consisting of a piece of heavy fabric attached to and between two side poles. Special cleats and collapsible legs permit the stretcher to be raised from ground. A stretcher should be removed from its case frequently in order to make sure that the case has not dried up so as to make removal of the stretcher from it under emergency conditions difficult.

Improvised Stretcher. In many cases, a regular stretcher is not suitable for removing an injured person from upper stories of a building, owing to winding stairways and other impediments to passage. To eliminate more injury to the patient by trying to place him on a regular stretcher and carry him under such conditions, it is often better that the regular stretcher be placed at the entrance to the building and that the men use a blanket as an improvised stretcher to carry the patient to the regular stretcher. The blanket may be placed under a severely injured person who is lying on his back by following certain steps. First, place the blanket lengthwise beside the patient and tuck (not roll) two-thirds of it snugly against the patient's body. Grasp the patient at hips and shoulders, and roll him gently about one-eighth turn away from the blanket. Push the tucked part as far under the patient as possible, roll him back over the tucked blanket and one-eighth turn in the other direction. Pull the tucked-up part of the blanket out from under the

patient. The patient is now in the middle of the blanket. Roll the edges of the blanket toward the body of the patient tightly in order to have hand support for the men to hold. The natural contours of the body prevent a person from falling out of this improvised stretcher. Thus where narrow or winding passageways are to be negotiated it is a very efficient device for carrying the injured.

If severely injured person is lying on his stomach rather than on his back, roll the blanket lengthwise until one-third of it is rolled and place the rolled part close to his body. Then gently roll the patient over on his back and on to the blanket. He is now in position to be carried as soon as the other side of the blanket is rolled.

For carrying an improvised stretcher, at least two men should be employed on each side of it. When the entrance of the building is reached, the men lower the patient on to the regular stretcher and cover him with the blanket which was used as the improvised stretcher.

First Aid Kits. Fire department first aid kits are large sized and contain the following supplies:

4-inch compress bandages	4-inch gauze bandages
2-inch compress bandages	large tube of burn ointment
1-inch adhesive compress	small tube of burn ointment
40-inch triangular bandages	absorbent gauze compress
mercurochrome swabs	wire splints
ammonia inhalants	adhesive plaster
ammonia ampoules	scissors
sodium bicarbonate	tourniquet
eye-dressing packets	forceps

Inhalator. A device to be used in conjunction with an approved manual resuscitation method to provide necessary oxygen to persons overcome by natural respiratory stoppage from such cause as carbon monoxide poisoning, gas asphyxia, electric shock, and drowning, and also to be used as a supportive treatment in cases of pneumonia.

Resuscitator. A machine which exerts an alternating positive and negative pressure on the lungs through a mask over the face of the person overcome by natural respiratory stoppage.

The mechanism of the resuscitator is contained within a central cylinder. Its motivating power is derived from the pressure in oxygen tanks.

In regard to the resuscitating of the new born, it is of the utmost importance that the mucus be removed from the respiratory system of the baby before any form or type of resuscitation is started. If this is not done, the baby will inspire the mucus down into its lungs.

WATER TOWERS

A water tower is a piece of mobile fire apparatus which has a pivoted, metal tower, enclosing a 3½-inch hose, mounted upon it. This tower may be raised so that water may be passed through the hose and directed horizontally through a nozzle at the peak of the tower, at any point up to 60 feet above the base of the tower, into a building which is on fire.

Water is supplied to a water tower from a pumping engine, or from a high pressure hydrant, through hose attached to the water tower inlets. There are three inlets for water on each side of a tower, and, on some towers, there are three such inlets on the rear end of the tower. These inlets have female connections for 2½-inch hose. Clapper valves are placed on these and all similar connections of the water tower to prevent water from being forced back, when a nozzle is shut down, through lines of hose on which there is less pressure, or from being forced out through a connection to which no hose has been attached.

Some towers have deck guns mounted on the base which may be used while the tower is in operation. A valve on the pipe from the main water supply controls the water supply to these deck guns.

Placing Tower. Until the tower is called into action, it should be kept at sufficient distance from the fire so that it may be turned to take any position desired. When orders are received to put the tower into action, unless orders to the contrary are received, the tower should be placed so that when erect it will be equally distant from both ends of the building on which it is to be used, and at such a distance from that building as to insure that the stream can be sent through any window within reach. Fire fighters should be cautious of overhead obstructions when raising the tower.

Operating Tower. Some water towers are raised by water pressure and others by springs. A water pressure raised tower requires a pressure of 125 pounds per square inch to raise it and 45 pounds per square inch to lower it. With this type of tower, in cold weather, after the tower is raised, the water should be kept circulating through the cylinders to prevent its freezing in them.

The tower should be raised and lowered slowly and brought to a stop gently. After the tower has been raised, the nozzle is extended to the desired height and locked in position. Guy lines should be fastened in the direction in which the tower is to play to prevent nozzle reaction from tipping the tower backward. The gate valve in the waterway is opened when orders are received to direct water on the fire. If the tower should start to tip, the water pressure should be reduced by closing the gate valve in the waterway. The vertical direction of the nozzle is controlled by a wire rope on a drum and the horizontal direction is controlled by a handwheel, both controls being capable of being operated from the base of the tower.

MISCELLANEOUS EQUIPMENT

Smoke Ejector. Smoke ejectors are used for removing air containing heat, smoke, toxic gases and other products of combustion from a fire building to a safe location outside, or for forcing fresh air into a building. This appliance may also be used in connection with tanks containing volatiles and in sewers, manholes, tunnels and other locations where it is necessary to provide a circulation of air.

Smoke Ejector—Electrically Operated Type. This type ejector is a powerful, portable fan unit operated electrically. It is provided with necessary fittings to connect to portable generators, or lighting units. This type ejector is usually available in 16 inch and 24 inch sizes. When used to force fresh air into a building after a fire, a deodorant may be used to expedite the removal of smoke odors.

Smoke Ejector—Water Pressure Operated Type. This type ejector is in service in some fire departments at locations where they may be readily transported to the scene of a fire or other place where its service may be required. There is supplied with each ejector 3 lengths of flexible suction pipe and a tarpaulin so arranged as to encircle the exterior of the suction pipe and to cover in window openings, air shafts, hatchways, etc., where the ejector may be used.

Portable Light Unit. A simple, portable motor-driven generator for producing electricity to illuminate buildings and surroundings at a fire, thereby facilitating rescue work, ventilation and fire fighting operations, and to operate power tools or pumps. It is also useful in cases where lighting is required when the fire department is asked in emergencies to assist in event of drownings, or where power failure in hospitals occurs.

The portable light unit is usually provided with three 500-watt and one 300-watt portable lights with sufficient portable extension cord to reach remote locations.

Wheat Light. A wheat light is an adaptation, for use in fire departments, of the miner's light. Enough wheat lights are usually provided in all fire departments so that every man on duty can be equipped with one. The light affords maximum protection for a man when working in dark or smoky places, since it throws a very brilliant and piercing light. It is so arranged that it can be worn on the spanner, axe or dog belt. This light should be put on while responding to alarms. A man should not be allowed to enter a smoke-filled building without such equipment because, if he does so, the instant his vision is obscured, he is useless to himself and the entire company, becoming a liability instead of an asset to efficient operation. In fact, many times his own life is dependent on his wearing such equipment. The wheat light is supplied with a non-leakable wet battery which can give service for twelve hours on a 1-ampere bulb. The battery is charged in the fire station from

a charging board which is provided for the purpose. The responsibility for proper charging and upkeep of such equipment rests upon the individual member.

Wheat Light—Dry Battery Type. A portable hand light with provisions for shoulder carrying strap. Capable of up to 40,000 beam candlepower, adjustable focus, powered with dry cell type battery which is replaceable.

Post Hydrant. A plug which is connected to a water main for the purpose of providing water at accessible locations for extinguishing fire. A post hydrant has six parts: the pot, the barrel, the bonnet, the valve, the operating nut, and the stem. The pot (or outer casing) is bolted directly to the water main. The barrel (or inner casing) is secured to the pot. Barrels vary in diameter from 6 to 10 inches and larger, but the standard used in most cities and towns is 8 inches. The valve is located at the base of the pot and it is provided with a long stem which reaches to the under surface of the bonnet. The bonnet is secured to the top of the barrel. At the top of the stem of the valve and secured in place by the bonnet is a five-sided operating nut. A hydrant wrench is placed on this operating nut and turned to open or close the hydrant. The hose outlets are located in the barrel and are usually about 18 inches above the ground level. The number and size of hose outlets vary in accordance with the requirements of cities and towns, but the standard fire hydrant is usually provided with two 2½-inch and one 4½-inch outlets with National Standard male hose threads. All hose outlets are provided with cast iron caps to protect hose threads. Some hydrants are provided with independent gate valves for each hose outlet. In communities subjected to extremely cold weather, a frost jacket is placed around the barrel to protect the parts from damage from freezing.

The approved fire hydrant or fire plug is so constructed that when the valve is closed, the hydrant drain is opened, thus allowing all the water remaining in the hydrant to escape through an opening or drain at the bottom of the hydrant where it runs to waste into the ground through the open lower end of the frost jacket. When the valve is open, this drain is closed. If this drain is working properly and if the main valve is tight, the danger of water entering the barrel and freezing will be avoided.

Good hydrants, properly designed and installed, present a minimum of maintenance difficulties. The maintenance routine calls for the following steps:

- a. Keeping the hydrant accessible and unobstructed at all times.
- b. Periodic testing of the operation of the hydrant to make sure that it is working properly.
- c. Periodic checking for leaks and of the condition of the gaskets.

- d. Oiling and greasing the threads of the butts and caps at regular intervals.
- e. Keeping the barrel well painted.
- f. Upon the approach of winter, and after use during winter months, testing hydrants for proper drainage to prevent freezing.

High Pressure Hydrant. Especially designed post hydrant with a capacity for a normal delivery of 2,000 gallons per minute. The hydrant has four independent male outlet valves bolted to the head. The varying pressures desired for the different lines of hose from the hydrant are regulated by the amount of opening of each independent valve and, with the special operating handles, any change of pressure for any line can be brought about very rapidly.

Chemical Foam Generator. Device for producing or generating a large-sized stream of fire foam for as long a period as foamite powder is fed into the hopper with water flowing through the generator.

The chemical foam generator consists of an open hopper with an ejector at the bottom. Fifty-pound containers of dry chemical foam mixture are emptied into this hopper, one after the other as the fire fighting progresses. A stream of fresh or salt water under a pressure of 75 to 100 pounds per square inch is led into the hopper at the bottom. It crosses a gap in the ejector, where it picks up the foam chemicals. From the hopper the stream passes through a 2½-inch line of hose that must be long enough to allow the chemical-bearing stream to mix thoroughly. Under ordinary climatic conditions the hose should be 100 feet long. When very warm water is used, 50 feet of hose is sufficient. The maximum length that can be used under any condition is 150 feet. The outlet end of the hose has a nozzle 1¾ inches in diameter.

NOTE: A shutoff nozzle is not used with this type of generator because if the line were to be shut down the foam solution would back up and cause an overflow at the foam hopper.

The rate of consumption of the foam powder in the generator is approximately 100 pounds per minute, with either fresh or salt water, at 70 degrees Fahrenheit. Since each pound of foam powder produces 8 gallons of foam, the foam production per minute is 800 gallons or 106 cubic feet.

Mechanical Foam. "Mechanical foam" or "air foam" is produced by mixing water, foam solution and air to produce a foam containing bubbles of air instead of carbon dioxide. Air foams generally have the property of readily flowing over a liquid surface and then "setting up" to a stiff foam.

The mechanical-foam nozzle consists of a 21-inch piece of flexible metal, or asbestos composition, 2 inches in diameter, with a solid metal nozzle outlet and, in the butt end, a suction chamber

and an air port. The foam discharged is a mixture of water, liquid-foam solution and air. The mechanical-foam nozzle is used with a pick-up tube attached to it, but the pick-up tube can be removed if desired.

When the pick-up tube is used with the mechanical-foam nozzle, it is attached by its hose end to the suction proportion chamber in the butt end of the mechanical-foam nozzle, just behind the air port. The metal-pipe is inserted into a container of mechanical-foam solution. One gallon of liquid-foam solution will produce about 160 gallons of mechanical foam. The contents of one can of liquid (5 gallons) will last approximately $1\frac{1}{2}$ minutes, and will produce about 800 gallons of foam in that time.

Carbon Dioxide Unit. This unit is a recent development in the use of carbon dioxide in fire fighting. It is mounted on fire apparatus to afford portable hose line protection. It consists of a pressure vessel, a refrigerator, the necessary controls, a suitable length of hose coiled in a basket on top of the unit, and a special playpipe and nozzle.

The unit contains 750 pounds of liquid carbon dioxide which is to be kept refrigerated at zero degrees Fahrenheit at a pressure of about 300 pounds. The tank, when full, contains approximately two-thirds liquid and one-third gas. While at the fire station, the refrigerator is plugged into an electrical current of 110 volts by means of an extension cord. The refrigerator unit is entirely automatic in operation, being controlled from the tank pressure by the tank pressure control switch. An audible alarm and suitable relief valves are provided in order to afford protection in case the tank pressure exceeds normal limits.

The hose is especially designed to withstand high pressure. On the end of the hose is a squeeze type, quick-acting valve, a playpipe and a nozzle. The nozzle is a low-pressure, high-velocity nozzle. The tank will be exhausted in $2\frac{1}{2}$ minutes of use, if the nozzle is kept open continuously.

Complete respiratory protection should be provided the operator of this unit, except when it is being used outdoors, as carbon dioxide, if breathed in too large quantities will cause suffocation. Any person overcome by carbon dioxide gas should be given the same first aid treatment as that given in a case of drowning.

RECOMMENDED FIRST AID PROCEDURE

First Aid Care

Definition of First Aid. First aid is the immediate but temporary care given in case of accident or sudden illness before the services of a physician can be secured.

Purposes of First Aid.

1. To prevent accidents by promoting safety consciousness.

2. To train people to provide proper first aid for the injuries involved.
3. To prevent added injury by administering proper first aid before moving person.
4. To provide proper transportation.

General Directions

1. Keep injured person lying down in a comfortable position, with head level with body, until you know the nature of the injury.
- 2a. Examine for serious bleeding, stoppage of breathing and poisons, in that order, first. They must be treated first.
 - b. Then look for fractures, burns, cuts, dislocations and head injuries. Be sure you find all the injuries.
3. Keep injured person warm, maintaining normal body temperature.
4. Send for a physician or ambulance as soon as possible or obtain medical advice by phone. In sending for assistance, give accurate facts as to location, number of injured persons, extent of injuries and first aid material available.
5. Do not be hurried into moving the injured person, until proper first aid care has been administered.
6. Do not give fluids to an unconscious or partly unconscious person as such fluids may enter the windpipe and choke the person. Do not give anything by mouth to a person who is vomiting or who feels nauseated, or to one who has been injured in stomach, chest or abdomen.
7. Keep the injured person cheerful and comfortable as possible and ease anxiety by reassurances. Keep onlookers away from injured person. Do not let the injured person see the injury or injuries.
8. REMEMBER: Few cases demand haste. Keep cool and calm. A good examination is important and can usually be done only slowly. There is nothing more important or more gratifying than the saving of a life or limb.

Wounds

Wounds are Classified Into Four Types:

- (1) Abrasions, made by rubbing or scraping, such as floor burns or scuff burns;
- (2) Incised wounds, sharp cuts that tend to bleed freely;
- (3) Lacerated wounds, jagged or irregular torn wounds;
- (4) Puncture wounds, such as a tack or nail wound.

The Principal Methods of Controlling Bleeding Wounds Are:

- (1) direct pressure;
- (2) elevation;

- (3) pressure points;
- (4) tourniquet.

When Bleeding Is Not Severe

1. Wash your hands thoroughly, using plain soap and water.
2. Cleanse the injury, using plain soap and boiled water at room temperature or clean running tap water and soap, applying the soap and water with a sterile dressing.
3. Apply a dry, sterile or clean dressing and bandage it snugly in place.
4. Tell the victim to see his doctor promptly.

When Bleeding is Severe

REMEMBER, IN ALL SERIOUS BLEEDING CASES TO THINK FIRST OF PRESSURE.

The principal objective in such cases is to stop the bleeding at once, almost always with direct pressure. Keep in mind that time is of the essence as a person may bleed to death in less than a minute when a large blood vessel is cut.

The First Aid Steps Are:

1. Always remove enough clothing so that wound can be seen clearly but do not remove material adhered to wound.
2. Stop bleeding at once, if possible, with hand pressure applied directly over the wound with a sterile cloth, if available, although application of the hand alone may be necessary for quick action in stemming major blood loss until more effective cloth material can be brought into use.
3. After the bleeding has been controlled, apply additional layers of cloth and bandage snugly in place. In case blood saturates the dressing, add more layers of cloth. Do not remove dressing.
4. In case of bleeding from an extremity, the use of elevation in addition to proper bandaging will reduce the flow of blood. If fractures are involved splint before elevation.

Pressure Points

For especially quick action in controlling the arterial bleeding from an extremity only, in some cases you can use your fingers or the heel of your hand to press the artery against the underlying bone. Such pressure causes the bleeding to diminish, but does not stop it entirely. Meanwhile measures to apply pressure directly over the wound with sterile compresses should be taken.

There are only two points on each side of the body where pressure against the supplying vessel is of occasional practical use:

1. Pressure on the inner half of the arm, midway between the elbow and the armpit, compresses the main vessel against the bone there and diminishes bleeding in upper extremity below the point of pressure.

2. Pressure applied just below the groin on the front, inner half of the thigh compresses the main vessel against the underlying pelvic bone. If considerable force is applied bleeding should diminish in the extremity below the point of pressure.

Tourniquet

The tourniquet is mentioned principally to discourage its use. Its application may cause tissue injury; it may completely shut off the entire blood supply to the part below, and the pressure device itself often cuts into or injures the skin if the tourniquet is not applied properly. "IT IS USED FAR TOO OFTEN."

REMEMBER: A TOURNIQUET IS ALWAYS A DANGEROUS INSTRUMENT AND SHOULD BE USED ONLY FOR SEVERE LIFE-THREATENING BLEEDING WHICH CANNOT BE CONTROLLED BY OTHER MEANS.

Tourniquets should be used only when severe bleeding involves an extremity in which large blood vessels are severed, or in cases of partial or complete severance of a body part.

Fire and Police Departments in most instances have for immediate use tourniquets either the regular type or the type which is inflated by a carbon dioxide cartridge. It would only be in cases where this equipment is not available that an improvised tourniquet would be required. Improvised tourniquet should be flat material about two inches wide, such as a cravat bandage, stocking, or a belt. Do not use a rope, wire, sash cord or metal band.

The Procedure for Application is as Follows:

1. Place the tourniquet close above the wound, between the main part of the body and the wound, but not at the wound edge. There should be normal or unbroken skin between the tourniquet and the wound. If the wound is near a joint, the application should be made at the nearest practical point above the joint.
2. Make sure that the tourniquet is applied tight enough to stop bleeding. If improperly applied, especially if not tight enough, it may increase venous bleeding.
3. Once the tourniquet is applied, the victim should be taken as soon as possible to a physician. The tourniquet should NOT be released, no matter how long it has been in place, except by a physician.
4. A notation should always be made and attached to the victim, giving the location of the tourniquet and the time of its application.
5. Cover the wound with sterile dressing and bandage.
6. In cases of seriously injured persons, always treat for shock.

Arterial and Venous Bleeding

Blood is circulated throughout the body by means of three different kinds of blood vessels: Arteries, veins and capillaries. Arteries are large vessels which carry the blood away from the heart; veins are large vessels which carry the blood back to the heart; and capillaries form a connecting network of smaller vessels between the arteries and the veins.

Arterial bleeding will gush out in spurts which are synchronized with the heart beats if the cut artery is near the surface, or in a steady stream if the cut artery is deeply buried. Arterial blood is usually bright red in color. Venous bleeding will come out in a steady, even flow if the vein is cut. Venous blood is usually dark red.

Shock

Of most importance to first aiders is traumatic shock, which is a depressed condition of many of the body functions due to the failure of enough blood to circulate through the body following serious injury and is associated with injury to body tissue from burns, wounds or fractures. In most instances it is caused by the loss of large quantities of blood.

The same first aid measures apply to both the prevention and the care of shock. It is important to conserve body heat. If the victim is lying down on the ground, floor or stretcher, place a blanket or blankets under him. Cover the victim only sparingly, according to the temperature of the environment, but do not cause sweating. Keep the victim lying down in a horizontal position, as this is the most favorable position if there is injury to internal organs and the head, or in case of fracture, except when there is difficulty in breathing in which case the head and chest should be elevated. If the blood loss is great, or the injury severe, the foot of the bed or stretcher should be elevated eight to twelve inches, except:

- (1) if there is a head or chest injury;
- (2) if breathing difficulty is thereby increased;
- (3) if the patient complains of pain when it is attempted, such as pain at the fracture site in the lower extremity or abdominal pain.

Sprains

If there is any possibility of fracture, immobilize the part as for a fracture. Otherwise, the first aid steps are:

1. Elevate the sprained joint upon pillows or substitutes. If it is a wrist, use a sling for the elevating.
2. Apply cold, wet application or an ice bag during the first half hour after the injury to reduce swelling.
3. Do not walk on sprained ankle until it has a protective support.

4. The sprained part should not be used until a doctor examines it.

Burns

All first aid treatment for burns should be directed toward relieving the victim's pain, preventing infection and combating shock. There are three general kinds of burns: thermal burns; sunburns; and chemical burns. Each of these burns are classified according to the depth or degree of the injury to the tissues. A burn which reddens the skin is called a first-degree burn. One which reddens and blisters the skin is called a second-degree burn. When the skin is destroyed and the tissues are actually charred or cooked, the injury is described as a third-degree burn.

The danger of infection is greatest in second- and third-degree burns. Shock is a major hazard in serious burns. Remember that the size of the burned area may be far more important than the depth of the burn.

The First Aid Steps Are:

1. Do not undress the person burned or uncover the burn. If the burn is already uncovered, apply sterile dressing to burned area using four or six layers. If sterile dressings are not available, use the cleanest available, such as a dry, clean, cotton sheet. Do not use absorbent cotton, such as fluff cotton or cotton batting as the fibers are hard to remove. The exclusion of air from the burn by the application of sterile dressing relieves pain and prevents further contamination. For lesser burns, the application of cold water is useful in relieving pain.
Do not break the blisters.
2. Treat for shock immediately.
3. Move him to hospital without further treatment. A severely burned person should be transported lying down, but if discomfort is increased or if difficulty in breathing is increased by such lying down he may be allowed to sit up.
4. Give nothing by mouth and apply no remedies on the surface of the burn.
5. In chemical burns, the chemical should be washed off with large quantities of clean water before applying dressing.

Fractures

A fracture is a break in a bone. There are two principal kinds, simple and compound. A simple fracture is a closed fracture not associated with an open wound extending from the skin to the fracture area. When such wound is associated, the fracture is an open compound fracture.

The objective of first aid care of fractures is to keep the broken bone ends and the adjacent joints quiet. If there is any

possibility that a fracture has been sustained treat the injury as a fracture.

The First Aid Steps Are:

1. If there is an open wound on the fractured limb, treat it in the manner described under "Wounds." When applying a dressing to the wound, support the limb on either side of the fracture during the bandaging to prevent movement of the broken bone.
2. If one of the long bones of the arm or leg is broken, straighten the limb carefully, by exerting a strong, steady pull at the end of the limb while the site of the fracture is gently supported over and under the fracture with the hands, before applying splints. If one end of the bone protrudes, straightening the limb may draw it back in place. Never attempt to force the end of the bone back into the wound nor to set a broken bone.
3. Prevent the motion of the broken bone by applying splints extending beyond the joint of either side of the broken bone. If manufactured splints are not available, they may be improvised from several thicknesses of newspapers, magazines, blankets, pillows, thin boards, etc.
4. Treat for shock immediately.
5. In general, a person with a fracture should not be moved until the fracture has been immobilized (i.e. until the motion of the broken bone has been prevented by the application of splints.) Never test for fracture by having victim move the part or by attempting to walk upon a possible broken limb. An ice bag may be used over the fracture to reduce or limit swelling and pain.

Head Injuries

Essentials

1. Suspect the injury in any accident due to force.
2. Keep the person quiet. Hurried transportation that disturbs and jostles the victim is a grave danger no matter how desperate his condition seems to be.

The First Aid Steps Are:

1. If the victim is unconscious, place a small pillow or substitute under the head and turn head toward the side so that secretion may drool from the mouth.
2. If he is conscious he may lay flat.
3. Whether he is conscious or not, give no stimulants.
4. If a dressing is needed for a scalp wound merely lay a large dressing over the injury, then apply a full head bandage.

Convulsive Seizures

Do not restrain the person in his convulsion, but protect him from injury. Push away nearby objects. Try gently to prevent him from biting the tongue by placing an appropriate object such as the edge of a book cover or spoon handle wrapped in a clean handkerchief or napkin, between his upper and lower teeth on one side of the mouth. Do not obstruct breathing. When the jerking is over, loosen the clothing about the neck and allow him to lie flat with head turned to one side or have him lay on abdomen to prevent vomitus from entering lungs. When he becomes conscious, do not disturb him, let him sleep, and keep him warm by maintaining body temperature.

Fire in Person's Clothing

A fire involving part or all of a person's clothing should be dealt with in the following manner:

Commencing at the shoulders of such person, wrap a rug, mat or any slow burning cover around him and roll him on the floor. (A first aider performing this operation should be careful that his own clothing does not become ignited. He should hold the cover in front of him and beginning at the shoulders of the person afire, throw the covering around him until it reaches his feet before wrapping the cover around him.) If the fire is in the person's own clothing and if he is alone, he should lie on the floor and roll to the nearest rug and wrap himself in it. He should not run to an open window, door, or to the street, as this action will fan the flames to an increased intensity.

Respiration—Asphyxia—Resuscitation

Respiration. Respiration or breathing is the act by which air is drawn into the lungs to supply the blood with oxygen, and the gases containing the waste products of the blood exhaled. It is normally controlled or regulated by a nerve center in the brain called the "Respiratory Center." As carbon dioxide accumulates in the blood, breathing increases in rapidity. As sufficient oxygen is taken into the blood, breathing becomes slower. Thus respiration is controlled by this nerve center which responds to either of these stimulations.

Asphyxia. This term literally means absence of pulse, but it is generally used to mean a whole series of symptoms which follow stoppage of breathing from any cause. It is caused by the paralyzing of the "Respiratory Center" by reason of physical shock, electric shock, shock during or after an operation, or, if the supply of oxygen essential to the maintenance of life is cut off, by suffocation, drowning, hanging, carbon monoxide or other gas poisoning, acute alcoholism, narcotics, etc., and it results in unconsciousness which, unless promptly treated, will be followed by death.

Resuscitation. The act of bringing back to life of one apparently dead. Cessation of either heart or respiratory action is

a major sign of impending death. Alone, or in combination, they present problems for definite and immediate action.

Artificial Respiration. While this term includes any method or means which produces artificially the inhalation and exhalation of the lungs, first aid is concerned primarily with manual artificial respiration since it can be applied immediately and without any equipment. Mechanical devices for inflating and deflating the lungs by means of positive and negative pressures have their place in first aid (if they are available for instant use), particularly in cases where the use of manual methods is made difficult because of broken back, broken ribs, burned areas of the body, pregnancy, physical shock, premature birth or other complications.

GENERALLY, EXCEPT IN CASES OF GAS POISONING, NO FORM OF ARTIFICIAL RESPIRATION SHOULD BE GIVEN TO ANY PERSON CAPABLE OF BREATHING, EVEN THOUGH HIS RESPIRATION BE DIFFICULT AND LABORED.

ARTIFICIAL RESPIRATION

After a person has stopped breathing, his heart usually continues to beat for a few minutes, and his life may be saved if proper Artificial Respiration is performed IMMEDIATELY. The reason why many people have failed to respond to Artificial Respiration is the fact that the treatment was not immediate. If you come across a person who has stopped breathing (usually discernible by the blueness of the victim), treatment should be started within seconds in order to induce breathing again, or the person will die. This is the most important point. It cannot be stressed too heavily. Do not wait to get the person out of the building before starting Artificial Respiration (unless the person is endangered by remaining in that building). Do not send him in an ambulance or allow for any other delay, but get to work IMMEDIATELY.

Standard Technique for Executing the Mouth to Mouth (Mouth to Nose) Method of Artificial Respiration for Adults.

1. Place the victim in a lying face-up position, and put something under his shoulders to raise them and allow the head to drop backward gently.

2. If there is foreign matter visible in the mouth, wipe it out quickly with your fingers or a cloth wrapped around your fingers.

3. Place your thumb in the corner of the victim's mouth behind the lower teeth, pull the lower jaw forward in order to keep the base of the tongue away from the throat, thus preventing obstructing of the airway with the tongue. With the other four fingers of this hand keep the jaw in a lifted jutting-out position. This hand is to retain this same position during the entire operation.

4. Open your mouth wide, inhale deeply and place it tightly over the victim's mouth. At the same time pinch the victim's nostrils shut or close the nostrils with your cheek. Or close the victim's mouth and place your mouth over the nose. Blow into the victim's mouth or nose. (Air may be blown through the victim's teeth, even though they may be clenched.)

The first blowing efforts should determine whether or not obstruction exists.

5. Remove your mouth, turn your head to the side, and listen for the return rush of air that indicates air exchange. Repeat the blowing effort. For an adult, blow vigorously at the rate of about 12 breaths per minute. For a child, take relatively shallow breaths appropriate for the child's size, at the rate of about 20 per minute.

6. If you are not getting air exchange, recheck the head and jaw position. If you still do not get air exchange, quickly turn the victim on his side and administer several sharp blows between the shoulder blades in the hope of dislodging foreign matter.

Again sweep your fingers through the victim's mouth to remove foreign matter.

Mouth-to-Mouth Technique for Infants and Small Children.

1. Place the child on his back and use the finger of both hands to lift the lower jaw from beneath and behind so that it juts out.

(Do not place the thumb in the child's mouth, as described previously for adults.)

2. Place your mouth over the child's mouth AND nose, making a relatively leakproof seal, and breathe into the child, using shallow puffs of air. The breathing rate should be about 20 per minute.

If you meet resistance in your blowing efforts, recheck the position of the jaw. If the air passages are still blocked, the child should be suspended momentarily by the ankles or inverted over one arm, and given two or three sharp pats between the shoulder blades, in the hope of dislodging obstructing matter.

Standard Technique for Executing the Back Pressure-Arm Lift Method, etc.

1. Place the patient in a face down, prone position. If possible his body should be slightly inclined in such a way that any fluid present will drain better from his respiratory passage. Bend his elbows and place his hands one upon the other under his head. Turn his face to one side and place his cheek upon his hands so that his nose and mouth are free for breathing. His head should not be bent forward and his chin should not sag lest obstructions in his respiratory passage occur.

2. Kneel on both of your knees, straddling the patient's head, your left knee near the patient's right hand and your right knee near his left hand. (Note: It is often more comfortable for the operator if he kneels on one knee, either his right or his left, in

which case his other foot should be placed near the opposite elbow of the patient.)

3. Reach forward and place your hands upon the flat of the patient's back with your wrists on a line running between his armpits, with the tips of your thumbs just touching each other, and with your fingers spreading downward against the patient's body. Rock forward slowly without bending your elbows until your arms are approximately vertical and allow the weight of the upper part of your body to exert slow, steady, and even pressure almost directly downward upon the back of the patient. Your elbows should be kept straight while this pressure is being exerted. This pressure should be adjusted to your own weight and the age, size, etc., of the patient. Release the pressure on the patient's back, avoiding a final thrust, and at the same time commence to rock slowly backward. Place your left hand under the patient's right arm and your right hand under the patient's left arm just above his elbow in each case. As you rock backward draw his arms upward and towards you. Do not bend your elbows. Apply just enough lift to feel resistance and tension at the patient's shoulders. Gently drop the patient's arms to the ground.

4. The complete cycle as described in paragraph 3 should be repeated 12 times per minute at a steady uniform rate.

5. The compression and expansion phases of the cycle should occupy about equal time, the periods between being of minimum duration. A smooth rhythm is desirable but split-second timing is not essential.

6. As soon as artificial respiration has been started or while it is being continued, an assistant (if available) or yourself (between cycles) should loosen any tight clothing about the patient's neck, chest or waist, should remove from the patient's mouth anything which might interfere with breathing, (false teeth, chewing tobacco, etc.) and should by pressing with the middle finger the patient's tongue forward, insure that it is in its proper place.

7. Continue artificial respiration without interruption until the patient's natural breathing is restored,—if necessary, for four hours or longer,—or until a physician declares that the patient is dead. If asphyxiation is caused by high voltage electricity, artificial respiration should be continued for at least eight hours.

8 Medical attention should be secured immediately. Do not be too anxious to move the patient immediately upon his reviving inasmuch as severe shock has been suffered by him. Quiet, rest and heat are essential to the prevention of heart strain and to the prevention of possible pneumonia due to lung congestion.

9. When the patient revives, he should be kept lying down and not allowed to stand or sit up so as to avoid strain on his heart. If the doctor has not arrived by the time the patient has revived, the patient should be given some stimulant, such as one teaspoonful

of aromatic spirits of ammonia in a small glass of water, or a hot drink of coffee or tea, etc. He should be kept warm.

10. Resuscitation should be carried on at the nearest possible point to the place where the patient received his injuries. He should not be moved from this point until he is breathing normally of his own volition and then should be moved only in a lying position. Should it be necessary, due to extreme weather conditions, etc., to move him before he is breathing normally, resuscitation should be carried on during the time when he is being moved.

11. A brief return of natural respiration is not a certain indication that the necessity for resuscitation is entirely at an end. Not infrequently the patient, after temporary recovery of respiration, stops breathing again. He must, therefore, be watched and if he does this, artificial respiration should be resumed at once.

12. In gas poisoning cases, artificial respiration is extremely helpful, even if the patient is breathing, in dissipating the carbon monoxide from the blood stream.

(Note: The use of the word "patient" in the material on first aid is used to indicate the person in need of immediate and temporary care. It is used for the lack of a better word. Its use is not intended to imply that the relationship of physician and patient exists between the first aid operator and such person.)

FIRE ENTRANCE EXAMINATIONS PHYSICAL STANDARDS

Applicants for entrance to the fire fighting forces are required to pass a physical examination and test of physical fitness. The following information, which contains the standards and requirements as of the date of printing of this Manual, is furnished for the general guidance of the applicants as to what will be required.

Eyes

1. Inspection. Applicants will be rejected for any pathological or other condition which may, now or hereafter, interfere with the proper function of the eyes in the performance of the duties of the position. Applicants will be rejected if they have squint, oscillation of eyes, or marked degree of drooping of the lids. In addition the following defects shall disqualify: Color blindness which will prevent the efficient performance of the duties of the position for which applicant is applying; chronic inflammation of the lids; strabismus (cross-eye); marked Ptosis; or permanent abnormalities of either eye.
2. Visual Acuity (clearness of vision) Applicants must have a visual acuity of at least 20 / 30, uncorrected, in one eye. The other eye shall be at least 20 / 80, uncorrected, corrected to 20 / 20.

Note: In explanation of "20/30", the numerator of the fraction -20- means the distance that the applicant is away from the eye chart; the denominator of the fraction -30- means the size of the letter on the eye chart.

Ears

1. Inspection. Applicants will be rejected for a missing external ear or any acute or chronic condition of a middle ear.
2. Hearing. Applicants must have an auditory acuity of 20 feet in each ear without any hearing aid or device, or in other words, be able to hear with each ear the whispered voice at a distance of 20 feet.

Nose

Applicants will be rejected for loss of nose and any nasal obstruction or deformity which will interfere with proper breathing.

Mouth

Applicants will be rejected for harelip, malformations, or tumors of the tongue, perforation of hard or soft palate, or any serious impediment of speech.

Teeth

Applicants must have twenty-four natural or artificial teeth.

Teeth must be clean. Teeth which cannot be repaired will be counted as missing. Crowns, bridges, partial and complete dentures will be accepted in replacing natural teeth. The Director may allow the applicant who fails because of the condition of his teeth thirty days in which to have the defects corrected, during which time certification of his name will be held in abeyance.

Throat

Applicants will be rejected for any acute or chronic condition which may now or hereafter interfere with the proper performance of the duties of the position.

General Appearance

Applicants will be rejected for any excessive obesity, thinness, or improper relation between height and weight, if such condition interferes with the duties of the position.

Height and Weight

Applicants will be rejected if they do not come up to the height and weight limits set by the city council or selectmen in accordance with the provisions of General Laws, Chapter 31, section 48.

Applicants will be measured in bare feet and weighed without clothing.

If any applicant does not come up to the required minimum standard on the first measurement, the Civil Service Medical Ex-

aminer will measure or weigh him again after a short interval at the same session and, if he is again found to be below the standard, he will be rejected and not allowed to go further in the examination.

When a test of physical fitness is required as part of the examination, the applicant may be rejected if in the opinion of the Civil Service Medical Examiner there is doubt as to whether he may safely take such test. Such applicant may appeal to the Director who may order further tests to determine the point.

General Physical

1. *Cardio-Vascular System*

Applicants will be rejected who have evidence of organic heart disease or arteriosclerosis (Hardening of the arteries), or a blood pressure which continues abnormally high on three successive examinations at reasonable intervals.

2. *Varicose Veins*

Applicants will be rejected for all except slight varicose veins.

3. *Varicocele*

Applicants will be rejected for all except slight varicocele.

4. *Hydrocele*

Applicants will be rejected for hydrocele of any degree.

5. *Respiratory System*

Applicants will be rejected who show evidence of any disease of the lungs which will interfere with the proper performance of the duties of the position.

If there is evidence of any disease of the lungs, the applicant must submit a medical lung test report from a recognized roentgenologist, hospital laboratory, or clinic approved by the Director.

6. *Abdomen and Gastro-Intestinal System*

Applicants will be rejected for hernia, actual or potential.

Applicants will be rejected for any condition of the stomach, abdomen or other organ in the gastro-intestinal system which will interfere with the proper performance of the duties of the position.

7. *Genito-Urinary System*

Applicants will be rejected if there is evidence of any disease of kidneys, bladder or genito-urinary system, syphilis in any stage, acute gonorrhea, or any condition which will interfere with the proper performance of the duties of the position. If there is evidence of kidney disease, the applicant must submit a complete urinary report from

a laboratory or clinic approved by the Director. If there is evidence of gonorrhea, a report from a laboratory conducted by the state, city or town or a private laboratory approved by the Director must be furnished by the applicant. If there is evidence of syphilis three negative Hinton reports from a state, city or town laboratory or a laboratory approved by the Director must be furnished by the applicant.

8. *Nervous System*

Applicants will be rejected if found to have evidence of any disease of the central nervous system, paralysis, etc., if the condition will interfere now or hereafter with the proper performance of the duties of the position.

9. *Spine—Bony Structures, Joints, and Muscles*

Applicants will be rejected for deformities, malformations, arthritic conditions, loss of limbs, loss of motion, curvatures and stiffness of spine, if condition will interfere with the proper performance of the duties of the position.

10. *Extremities*

(a) Hands. Applicants will be rejected for loss of thumb, or of a finger or fingers, or contractures or deformities, if such condition interferes with the proper performance of the duties of the position, and for any other condition which interferes with the proper performance of the duties of the position.

(b) Feet. Applicant will be rejected for flat feet, hammertoe, overlapping toe, loss of toe or considerable part thereof, contractures and deformities, if such condition interferes with the proper performance of the duties of the position, and for any other condition which interferes with the proper performance of the duties of the position.

(c) Muscular System. Applicants will be rejected for atrophy (shrinking) of muscles, loss of muscles, contractures, etc., which will interfere with the proper performance of the duties of the position.

11. *Skin*

Applicants will be rejected for any skin condition if it is of a contagious nature or one which will interfere with the proper performance of the duties of the position.

General Condition

Applicants will be rejected if found to have evidence of any other condition, not specifically described herein, which will interfere with the proper performance of the duties of the position.

MASSACHUSETTS CIVIL SERVICE TEST OF PHYSICAL FITNESS

Before attempting the test, it is advisable for each candidate to be sure he is in good physical condition and to have undergone training recently under the guidance of a qualified physical instructor or educator at a gymnasium or similar facility. This is believed to be necessary so that candidates may undergo the test without injurious results. The examiner will describe and illustrate each event. If candidate does not follow or comply with instruction, he will be given no credit and will be taken off that event. No change in the order of events is permitted. In each event any performance less than the lowest one rated is given 0 percent. A candidate must obtain a general average of 70 percent in the test.

	EVENT	RESULT	PER CENT	WEIGHT
MEASURE OF: STRENGTH (Back and legs)	1. DUMMY LIFT Candidate will stand astride the dummy. Arms should be well wrapped around the middle of the dummy. Candidate should lift the dummy from the floor to his chest in one motion. From the chest position, candidate may use legs in jumping dummy onto his shoulder. Examiner will notify candidate when he has dummy in proper position. Candidate will then lower dummy returning it gently to its original position. Two tries given on each weight starting with 150-lb. dummy. Candidate starting with 125-lb. dummy will not be allowed a later trial on 150 lb. dummy.	150 lbs. 125 lbs.	100 % 70	4
POWER AND AGILITY (Legs)	2. STANDING BROAD JUMP Toes must be kept behind the take-off mark. Toes extending or sliding over this mark on the take-off will count as one try, but no credit will be allowed for this jump. Bouncing or crow-hopping on the take-off disqualifies the jump. Measurement of the jump is taken from the nearest part of the body touching the mat towards the take-off mark. Three tries will be given and the result of the best jump will be taken.	8'0" 7'8" 7'4" 7'0" 6'8"	100 % 90 80 70 60	5

STRENGTH
(Arms and
shoulders)

3. **DUMBBELLS** Weights: 75-70-65-60-50 Weights may be lifted from floor to shoulder with either one or both hands. There must be definite pause with the weight at the shoulder. From shoulder position the weight must be pushed or pressed upward until the arm is fully extended over the head. After the weight has reached the shoulder position, the candidate must keep heels on the floor, knees must be straight, hips firm until the lift has been completed. Jumping the weight up by bending and then extending the knees, rolling and snapping of hips or body to start the weight is not permitted. Two tries with each hand on each weight starting with the heavier weights are permitted. Right and left hand lifts are added together for total.

Total both hands		
150 lbs.	100 %	5
145 lbs.	95	
140 lbs.	90	
135 lbs.	85	
130 lbs.	80	
125 lbs.	75	
120 lbs.	70	
110 lbs.	65	

**MUSCULAR
ENDURANCE**
(Abdominal
muscles)

4. **ABDOMINALS** From supine position, with arms back-of-neck, and feet and knees anchored by partner, candidate will come to a sitting position keeping legs and thighs on the mat. Arching, throwing elbows forward, or bounding off back in order to sit up is not allowed. Improper performance does not rate partial credit. Once the candidate begins the test he must continue without stopping; he will not be allowed to start over again.

Sit-Ups	100 %	4
30	90	
25	80	
20	70	
15	60	
10		

MUSCULAR
ENDURANCE
(Arms and
shoulders)

5. ROPE CLIMB Standard gymnasium climbing rope marked at 2 ft. intervals from the mark 14-ft. above the floor. Climb is started with candidate standing at foot of rope and grasping rope at convenient height. Climb must be done by hand-over-hand method. Arms only are permitted to be used. There will be no contact on the rope by squeezing or nipping with the legs during the climb. Candidate must climb 14-ft. to get the minimum marking of 60 percent. Any climb less than this is complete failure in event. Only one try will be given.

22'	100 %	4
20'	90	
18'	80	
16'	70	
14'	60	

AGILITY AND
COORDINATION
(Total body)

6. FENCE VAULT A standard gymnasium low horizontal bar is used. Standing or running start is allowed. No part of body may touch bar except hands. Candidate must release his hand grip on bar before he lands on far side of mat. Candidate will be given three tries at each height.

5'6"	100 %	6
5'0"	85	
4'6"	70	

BACK AND LEG
STRENGTH
AGILITY AND
BALANCE

7. LADDER Equipment — 18 ft. straight-side ladder placed against balcony or running track. 125-lb. dummy placed on floor of balcony or running track near ladder. Bottom of ladder braced against floor clear to prevent slipping. Top of ladder held by two safety men in balcony or track. Candidate starts from standing position at foot of ladder. He climbs to balcony or track, steps off onto balcony or track, lifts dummy to shoulder, and remounts ladder to descend. It is advisable to use fireman's carry on dummy. He then descends ladder with dummy on shoulder. Event is completed when candidate reaches floor at original starting position. Dummy must be under control throughout the event. Event on the time basis. Only one try allowed.

Seconds	100 %	7
35	90	
36-40	80	
41-45	70	
46-50	60	
51-55	50	
56-60		

CARDIO-
RESPIRATORY
ENDURANCE
(Heart, vessels
and lungs)

8. 440-YARD RUN To be
marked on time basis. Only one
try allowed.

Seconds	100 %	10
70-75	85	
76-80	70	
81-85		

SKILL
(Total body)

9. 100-YARD SWIM No time
limit, but swim must be con-
tinuous without pausing at the
turns. Crawl, breast, back or
side strokes, or any com-
bination of these is permitted,
but no dog-paddling or idling
on back is allowed This event is
mandatory for police entrance
and metropolitan police en-
trance.

No time limit	100 %	5
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APPEALS, POSTPONED EXAMINATIONS AND RE-EXAMINATIONS

Physical Examinations and Tests of Physical Fitness

When a test of physical fitness is required as part of the examination the applicant may be rejected if in the opinion of the Civil Service Medical Examiner there is doubt as to whether he may safely take such test. Such applicant may appeal to the Director who may order further tests to determine the point. An applicant is expected to appear for physical examination or test of physical fitness on the date and at the place for which notified.

POSTPONEMENTS MAY BE ALLOWED FOR GOOD AND SUFFICIENT REASONS UNDER THE FOLLOWING CONDITIONS:

1. (a) For applicants unable to appear on the day specified in the notification.
(b) For applicants who appear and find that they are unable to take the physical examination or test of physical fitness. (In these cases, the applicants must report to the examiner and tell him of their inability and the reasons therefore.)
2. In any case, the request for postponement or rescheduling must be made in writing to the Director promptly, and must contain a full statement of the reasons for not appearing or taking said examination or test as notified. If the reasons given are sufficient to permit the setting of another date, every attempt will be made to set the date prior to the establishment of the eligible list.
3. In the case of any postponement or rescheduling, applicants will be notified to appear with all other applicants for the same class whose request for postponement or rescheduling have also been allowed.

IN NO CASE WILL THE ESTABLISHMENT OF THE ELIGIBLE LISTS OR CERTIFICATION OF NAMES TO AN APPOINTING AUTHORITY BE DELAYED PENDING A LATER PHYSICAL EXAMINATION.

Interruption of Test of Physical Fitness Due to Illness or Injury

An applicant who has begun his test of physical fitness is expected to complete the test on the day assigned, unless he has been excused by the examiner as soon as it occurs. In a case where the examiner so excuses the applicant, the examiner shall make a record to that effect on the applicant's physical examination sheet. If an applicant who has been so excused has attained, prior to such excusal, marks sufficiently high to warrant the possibility of his receiving a general average passing mark in the test had the illness or injury not occurred, the Director may, after a review of all the facts, allow the applicant to take the test of physical fitness at a later date. If, however, the applicant fails to report his injury or illness in the manner set forth above or if he reports such injury or illness after receiving marks so low that even if he had completed the remaining events he would not have received a passing mark, he must abide by the mark obtained in the test.

Appeals

If you fail to pass the physical examination or test of physical fitness you will be so notified. At that time, your rights of appeal will be set forth.

Physical Examinations and Test of Physical Fitness after the Establishment of an Eligible List

At any time after the effective date of the establishment of an eligible list if no suitable eligible list exists, the Director may renotify a class to appear for a physical examination or test of physical fitness whenever a vacancy occurs. An applicant who has not passed a physical examination or test of physical fitness may, after the effective date of the establishment of an eligible list, request renotification; and the Director may reschedule the physical examination or test of physical fitness. In the latter case, the request must be made in accordance with the instructions above under POSTPONEMENTS.

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